

STATE OF THE PAVEMENT 2018

October 2018

Comments should be directed to

Branco Vlacich

Maintenance Division Administrator

Virginia Department of Transportation

1401 E. Broad St, Richmond, VA 23219

phone: (804) 786-2949

e-mail: Branco.Vlacich@vdot.virginia.gov



EXECUTIVE SUMMARY

The Virginia Department of Transportation (VDOT) is responsible for more than 128,000 lane miles of roadway. Virginia’s current highway network is the result of more than 100 years of investment in infrastructure that provides safe, easy movement of people and goods and enhances the economy of the Commonwealth. Preserving this investment is a core function of VDOT.

This report describes the pavement condition and ride quality on Virginia’s pavements based on data collected, processed and analyzed during the early months of 2018. It also provides trend analysis over the last five years of pavement condition ratings. The information in this report is used to understand variations in pavement condition and ride quality by pavement type, highway system, maintenance district and county.

This report provides background information on the methodology of data collection, quality assurance of data, derivation of condition measures, and the use of pavement condition data to assess pavement sufficiency statewide.

The report is organized into two major areas: (i) pavement condition data collection, data processing and quality assurance, and (ii) statewide pavement condition and ride quality summary. Appendices provide detailed pavement condition and ride quality data and the distribution of key distresses by district and pavement types.

The data presented in this report comprise a “snapshot” of pavement conditions during the early months of 2018. The data displayed highlights the pavement condition and ride quality summary. These results are broken down into further detail in the main body of this report. Throughout this report the abbreviations in Table I are used to denote the construction districts. Table II below shows the mileage by system maintained by each district based on the last published mileage tables.

Table I: Abbreviations for VDOT Districts

District Number	District Name	Abbreviation
1	Bristol	1/BR
2	Salem	2/SA
3	Lynchburg	3/LY
4	Richmond	4/RI
5	Hampton Roads	5/HR
6	Fredericksburg	6/FR
7	Culpeper	7/CU
8	Staunton	8/ST
9	Northern Virginia	9/NO

Table II: Lane Mileage by District and System

District	Interstate	Primary	Secondary	Frontage	Total
Bristol	530	2,982	12,323	114	15,949
Salem	493	2,668	14,756	108	18,025
Lynchburg	0	2,828	12,375	43	15,246
Richmond	1,323	3,462	14,093	75	18,953
Hampton Roads	876	1,782	7,148	87	9,893
Fredericksburg	290	2,184	9,419	23	11,916
Culpeper	279	1,870	8,361	52	10,562
Staunton	942	2,474	10,584	75	14,075
Nova	770	1,791	11,305	76	13,942
Statewide	5,503	22,041	100,364	653	128,561

PAVEMENT DATA COLLECTION, DATA PROCESSING & QUALITY CONTROL/QUALITY ASSURANCE

The pavement condition data presented in this report were collected and processed by VDOT's contractor, Fugro-Roadware Inc., using continuous digital imaging and automated crack detection technology. For data collection purposes, Fugro-Roadware uses vehicles equipped with special cameras to capture downward pavement images for crack detection as well as forward images for the collection of right of way images for assets and shoulder condition data. Roughness and rutting data are simultaneously captured with sensors mounted on the van. Downward images collected during the survey are processed with specialized automated crack detection software for the identification of cracks. Further analysis of the digital images is necessary for the identification of other distresses, such as patching, bleeding or delamination.

This year data was collected by the above-mentioned method on the entire Interstate and Primary highway system, and approximately 20% of Secondary system of highway network. The distresses are interpreted according to the methodology detailed in the VDOT Distress Identification Manual⁽¹⁾, processed, and summarized in a pre-defined format. Quality Control (QC) is conducted by the contractor and Quality Assurance (QA) and Independent Validation and Verification (IV&V) is performed by a third party consultant - Quality Engineering Solutions (QES). This consultant independently rates and verifies approximately 5% of all the data collected by the data collection contractor. For the Interstate and Primary systems the ratings on pavement sections are also compared with the previous year's ratings on the same sections and any major differences in ratings are further investigated. The data are processed, verified and delivered in batches. VDOT then accepts the data based on predefined acceptance criteria mentioned in the quality review document.

Individual distress data are aggregated into two Pavement Condition Indices, the Load-related Distress Rating (LDR) and Non-load-related Distress Rating (NDR). The LDR incorporates pavement distresses that are related to vehicle load related damages (e.g. fatigue cracking, patching, rutting, etc.) to pavement. The NDR is comprised of distresses (e.g.

transverse and longitudinal cracking, longitudinal joint separation, bleeding, etc.) considered to be primarily non-load related, i.e., caused by weathering of pavement surface or material and/or construction deficiency. Both indices are on a scale of 0 to 100 with 100 representing a pavement with no visible distresses. The details of the index calculation methodology for asphalt surfaced pavements are provided in a VDOT report⁽²⁾ published in 2002.

A third index – the Critical Condition Index (CCI) is calculated as the lower of the LDR and NDR. These indices were first derived in 1998 based on the PAVER methodology developed by the US Army Corps of Engineers, and have undergone extensive validation process using the Long Term Pavement Performance (LTPP) data collected through the Strategic Highway Research Program (SHRP) of FHWA and through a process of consensus building using numerous VDOT pavement experts. It should be noted that LDR and NDR are used only for asphalt-surfaced pavements. For jointed concrete pavements the Slab Distress Rating (SDR) is used while the Concrete Punchout Rating (CPR) and the Concrete Distress Rating (CDR) are used for continuously reinforced concrete pavements. However, the same concept of CCI applies to the latter two pavement types. More details about concrete pavement condition indices are documented in another published VDOT report⁽³⁾.

As shown below in Table III, CCI values are grouped into five ranges corresponding to condition categories: excellent, good, fair, poor and very poor. In general, pavement sections with a CCI value below 60 (poor and very poor) are considered ‘deficient’ and should be further evaluated for maintenance and rehabilitation actions. Pavement sections with a CCI value of at least 60 (fair or better) are considered ‘sufficient’.

Table III : Pavement Condition Category Based on CCI

Pavement Condition	Index Scale (CCI)
Excellent	90 and above
Good	70-89
Fair	60-69
Poor	50-59
Very Poor	49 and below

Pavement roughness is generally defined as an expression of the aggregation of irregularities in the pavement surface, per linear mile, that adversely affect the ride quality of a vehicle (and thus the user). Roughness is an important pavement characteristic because it affects not only ride quality but also vehicle delay costs, fuel consumption and maintenance costs. Pavement roughness or ride quality, expressed in the International Roughness Index (IRI), is derived from sensor data collected by the van simultaneously with the video images. IRI data has been analyzed and reported separately in this report. Table IV below contains a qualitative pavement ride quality term and corresponding quantitative IRI values. VDOT uses the categories summarized in Table IV for its Interstate, Primary, and Secondary systems.

Table IV : Pavement Ride Quality Based on IRI

Ride Quality	IRI Rating (inch/mile)	
	Interstate & Primary	Secondary Roads
Excellent	< 60	< 95
Good	60 to 99	95 to 169
Fair	100 to 139	170 to 219
Poor	140 to 199	220 to 279
Very Poor	≥ 200	≥ 280

Ranges of IRI that correspond to qualitative descriptors of ride quality were built upon similar categories promulgated by FHWA⁽⁴⁾ and incorporated consensus opinions from VDOT pavement experts regarding what thresholds were considered appropriate to represent acceptable roughness levels on Virginia highways. Interstate and Primary pavement sections with an average IRI of 140 or more or a Secondary pavement section with an average of IRI of 220 or more are considered ‘deficient’ in terms of ride quality.

STATEWIDE PAVEMENT CONDITION AND RIDE QUALITY SUMMARY

For the Interstate, Primary, and Secondary systems, the statewide pavement condition and ride quality summary is presented in the Figures I, II and III. Tables III and IV above provided definitions of the pavement condition and ride quality categories shown in the figures.

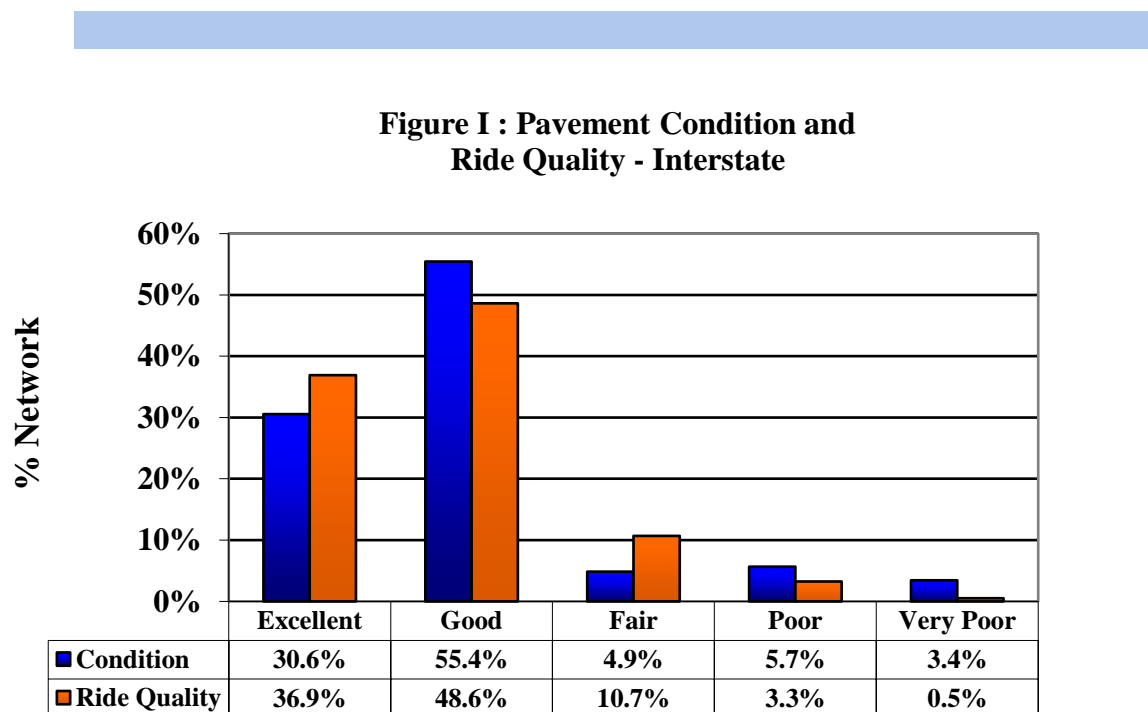


Figure II : Pavement Condition and Ride Quality - Primary

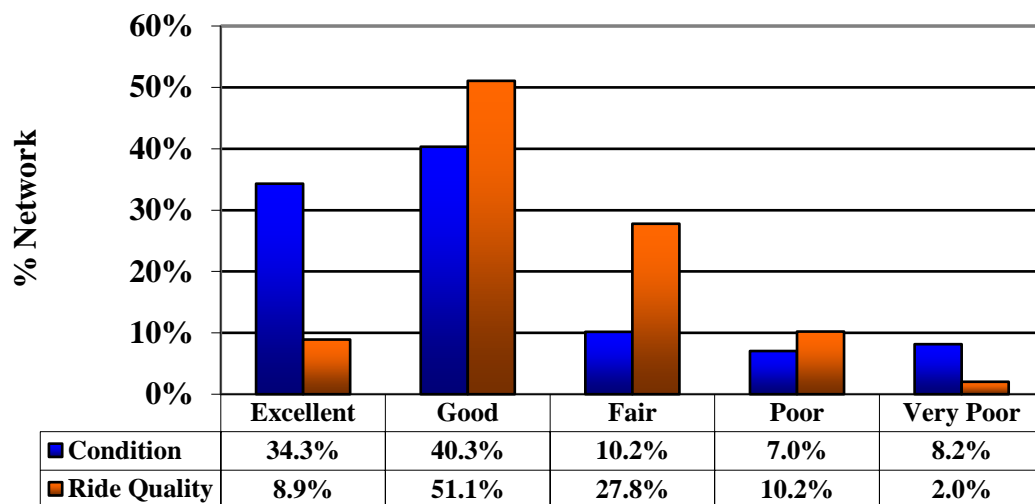
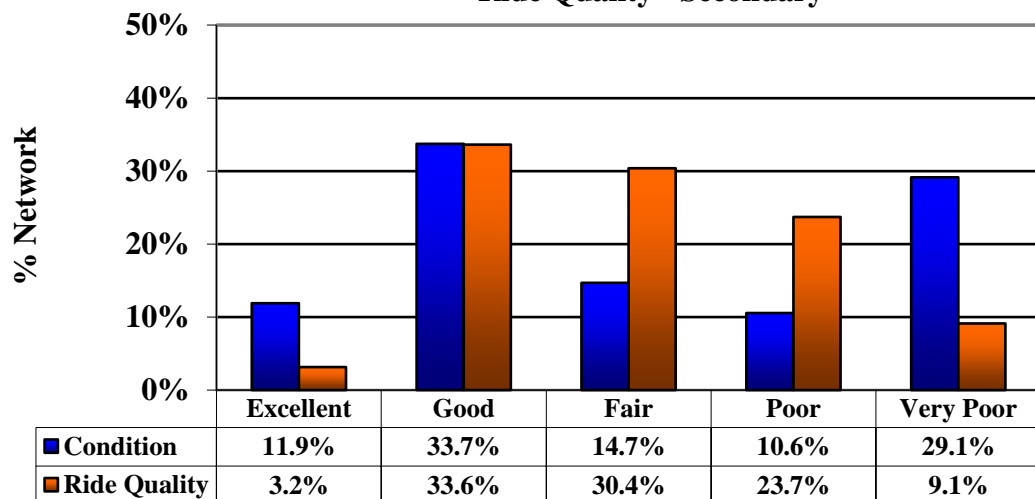


Figure III : Pavement Condition and Ride Quality - Secondary



Interstate Pavement Condition and Ride Quality by District

The following graphic shows the pavement ratings for the Interstate pavement system. Following this graphic, the detailed ratings for the system are reported.

The statewide performance target for percentage of Interstate pavements rated sufficient, i.e., in fair condition or better, is 82% or more. Similarly, the performance target for statewide sufficient ride quality on the Interstate systems is 85% or better. Figure IV shows the percent sufficient on the Interstate system by district based on pavement condition and ride quality. More than 90% of the Interstate network has been rated to be in ‘sufficient’ condition and more than 96% has sufficient ride quality. These are illustrated in Figure IV with each district’s pavement condition and ride quality along with statewide statistics. Figure V presents the total number of deficient lane miles in each district on the Interstate system.

The number of miles maintained by each district varies considerably, therefore, one district may have a larger percentage of miles in sufficient condition but fewer lane miles sufficient than another. The percent of lane miles rated sufficient varies from as high as 99.3% in Fredericksburg District to as low as 84.4% in Staunton District. Richmond District maintains the largest number of Interstate lane miles while Lynchburg District does not maintain any Interstate pavements. On the Interstate system, the ride quality sufficiency varies from as high as 99.3% in Staunton District to as low as 90.9% in Hampton Roads District.

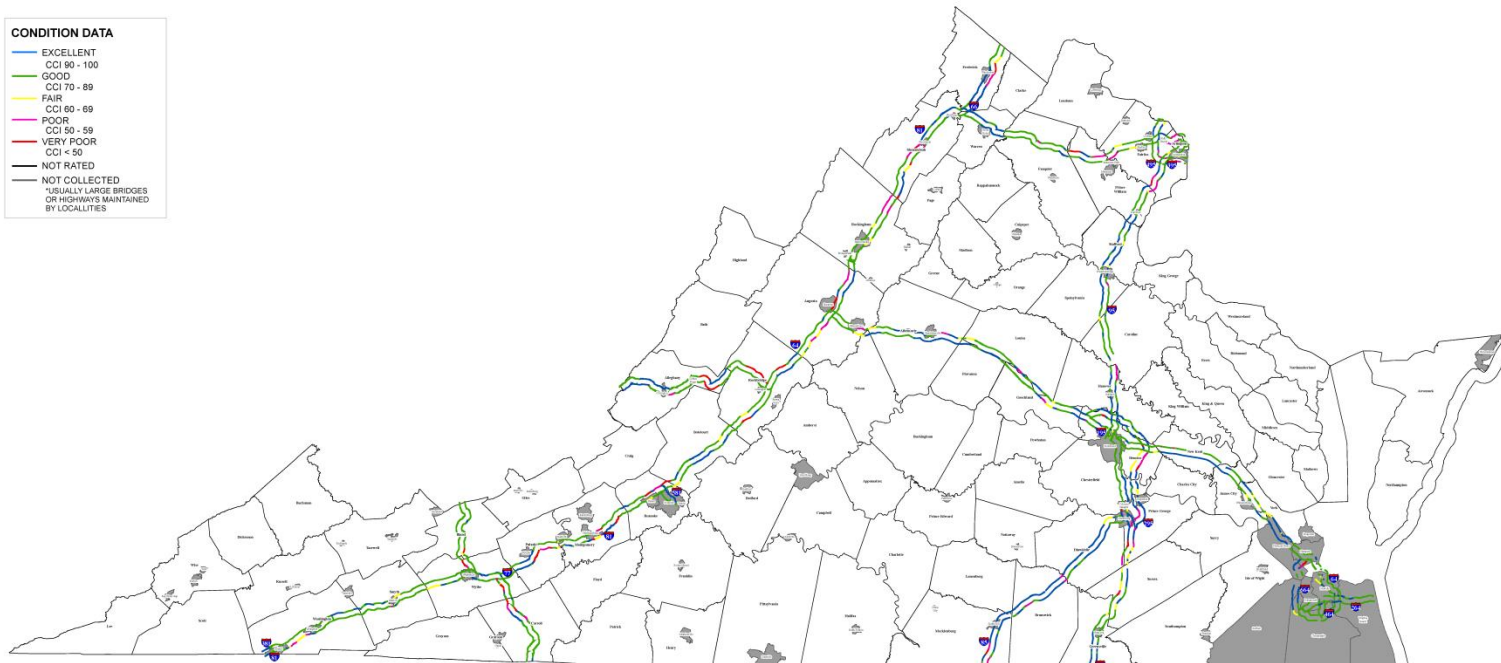


VDOT Interstate Conditions 2018

VIRGINIA DEPARTMENT OF TRANSPORTATION
PAVEMENT CONDITIONS 2018
INTERSTATE ROUTES

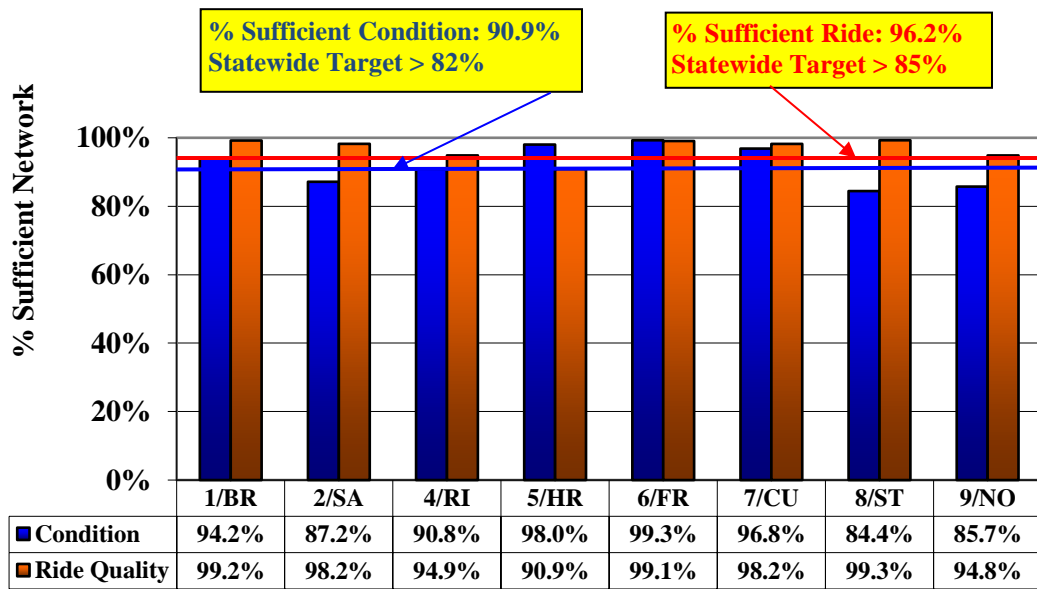
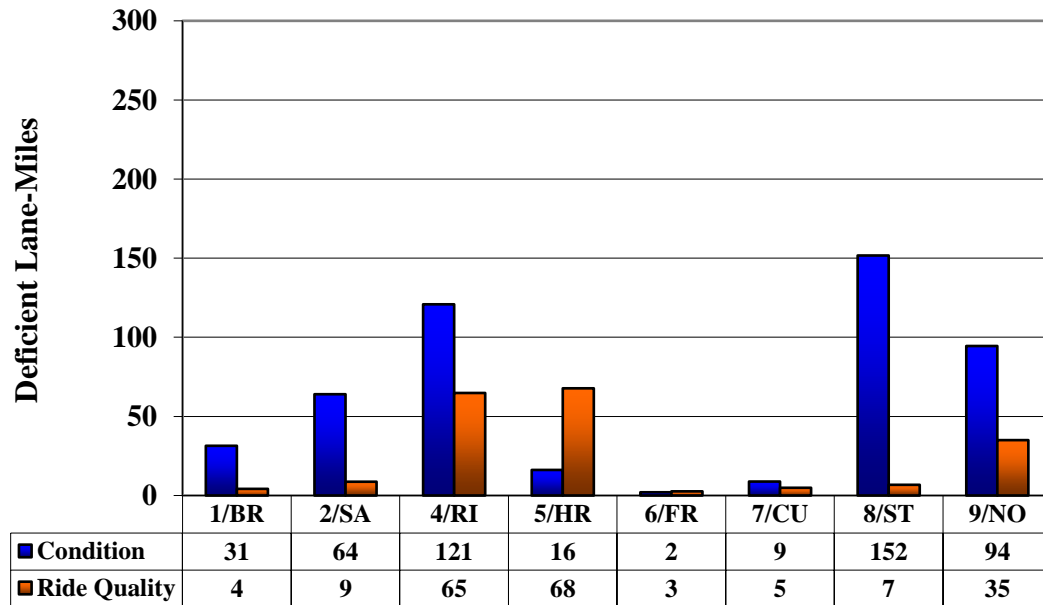


CONDITION DATA	
EXCELLENT	CCI 90 - 100
GOOD	CCI 70 - 89
FAIR	CCI 60 - 69
POOR	CCI 50 - 59
VERY POOR	CCI < 50
NOT RATED	
NOT COLLECTED	
*USUALLY LARGE BRIDGES OR HIGHWAYS MAINTAINED BY LOCALITIES	



0 37.5 75 150 Miles

VDOT Virginia Department of Transportation
Maintenance

Figure IV: Percent Sufficient by District - Interstate**Figure V: Deficient Lane Miles by District - Interstate**

Primary Pavement Condition and Ride Quality by District

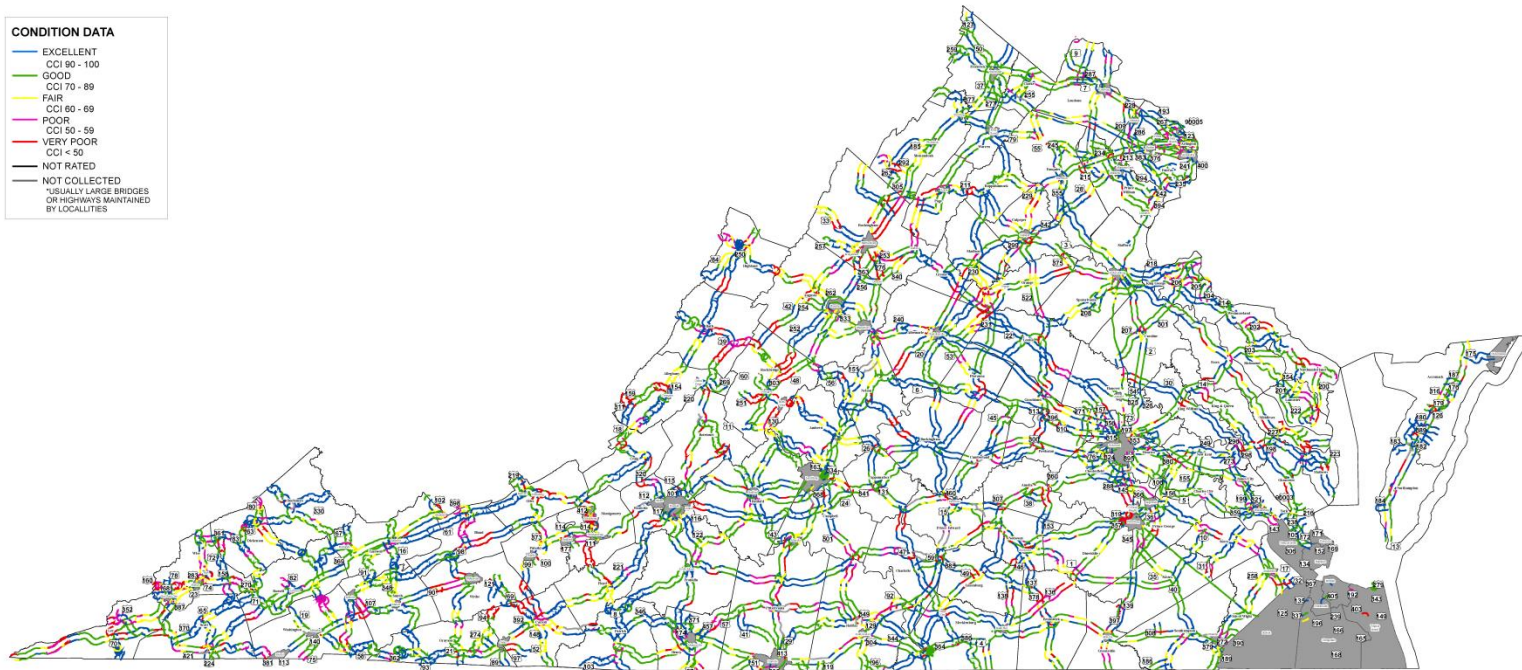
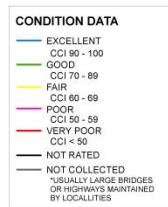
The following graphic shows the pavement ratings for the Primary pavement system.

Figures VI and VII show pavement condition and ride quality summaries for the Primary pavement network. Figure VI shows the percent of sufficient network by district based on pavement condition and ride quality along with statewide figures. Figure VII shows the number of deficient lane-miles in each district. Current VDOT performance targets are for 82 percent or more of pavements to be in sufficient condition and for 85 percent or more to have a sufficient ride quality. Based on the data, approximately 84.8% of the Primary network has been rated to be in sufficient condition and 87.8% has sufficient ride quality.

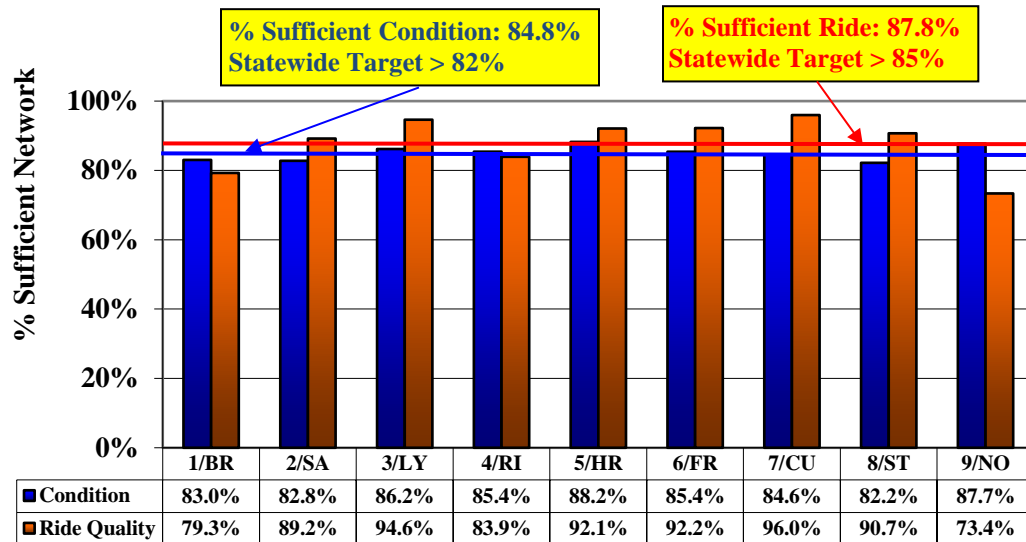
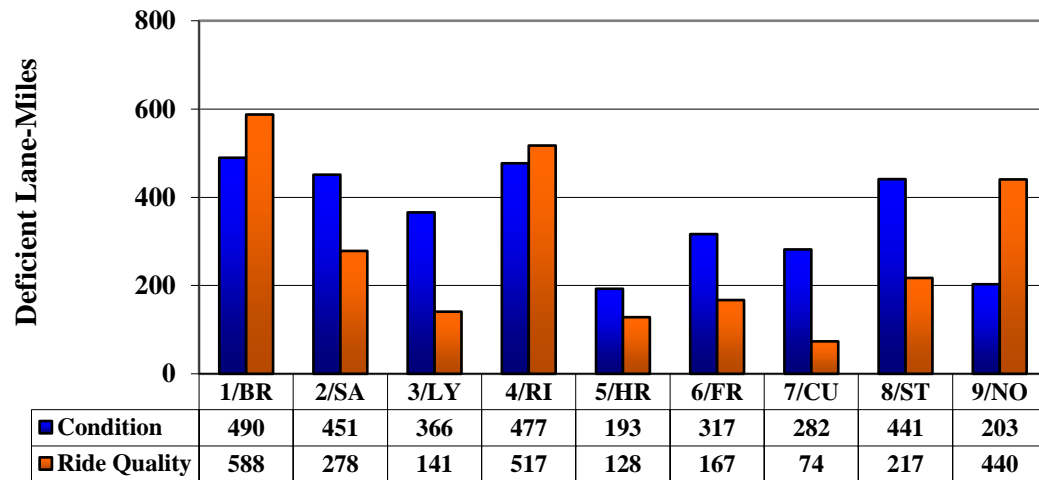


VDOT Primary Conditions 2018

VIRGINIA DEPARTMENT OF TRANSPORTATION
PAVEMENT CONDITIONS 2018
PRIMARY ROUTES



0 37.5 75 150 Miles

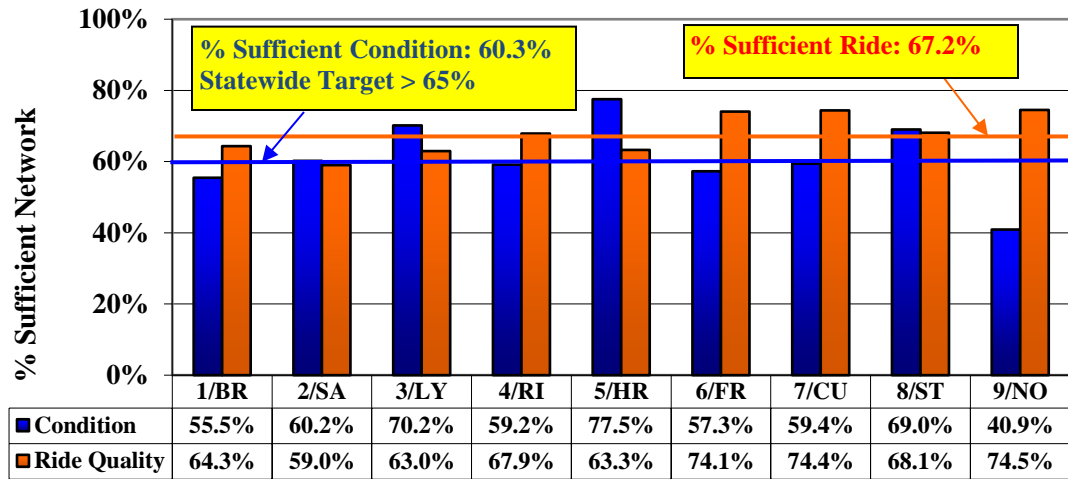
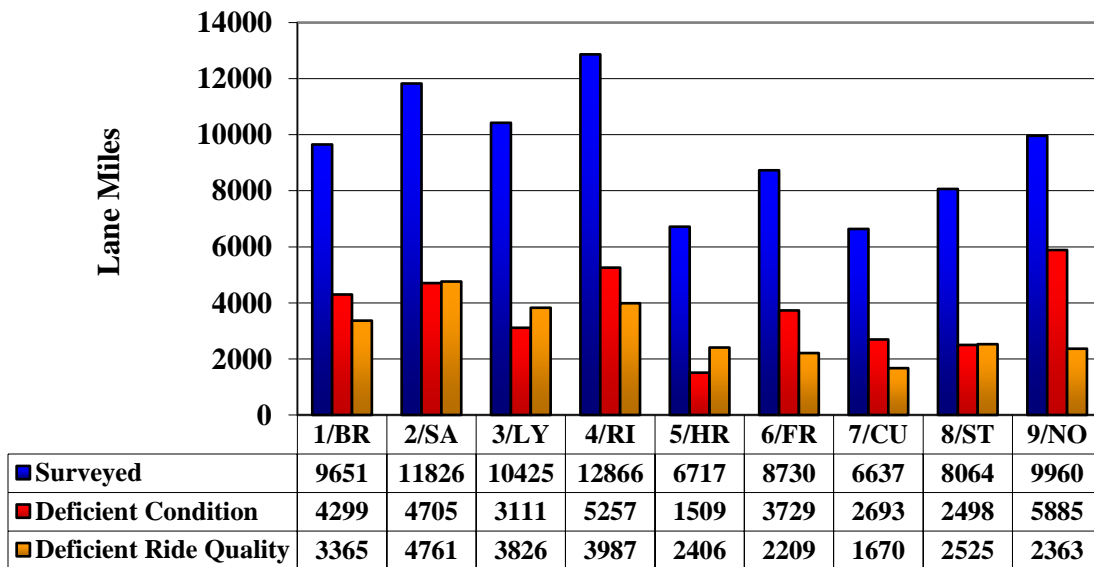
Figure VI: Percent Sufficient by District - Primary**Figure VII: Deficient Lane Miles by District - Primary**

Secondary Pavement Condition and Ride Quality by District

In 2016 data was collected on 100% of VDOT maintained hard-surfaced secondary pavements. In 2017 and 2018, data in each county was collected for approximately 20% of the network. For most of the locations, the data collected in 2017 and 2018 was also collected in 2016, so the condition of the entire secondary network is summarized using the most recent data available (either 2016 or 2017 or 2018).

Figure VIII shows the percent sufficient network by district based on pavement condition and ride quality. Figure IX represents the number of lane miles surveyed and the number of deficient lane miles in terms of condition and ride quality. Based on these figures, Northern Virginia District has the lowest percentage of its Secondary rated as sufficient, followed by Bristol and Fredericksburg Districts. Hampton Roads District has the highest percent of sufficient Secondary pavements (77.5%). Statewide, 60.3% of the sampled Secondary system was found to have pavement condition rated sufficient.

Based on ride quality, the sufficient ratings range from a low of 59% sufficient in Salem District to a high of 74.5% in Northern Virginia District. Statewide 67.2% of the Secondary system has sufficient ride quality.

Figure VIII: Percent Sufficient by District - Secondary**Figure IX: Surveyed, Deficient Condition and Deficient Ride Quality Lane Miles by District - Secondary**

Statewide Pavement Deficiency Trends

The trends over recent years in Interstate and Primary percent sufficient network are shown in Figure X; trends for the Secondary pavements are shown in Figure XI. The higher the percentage of sufficient pavements, the better is the pavement network condition in general. In Figure X, the statewide performance targets of 82% sufficient are shown for interstate and primary pavements.

Figure X: Trend in Percent Sufficient - Interstate and Primary

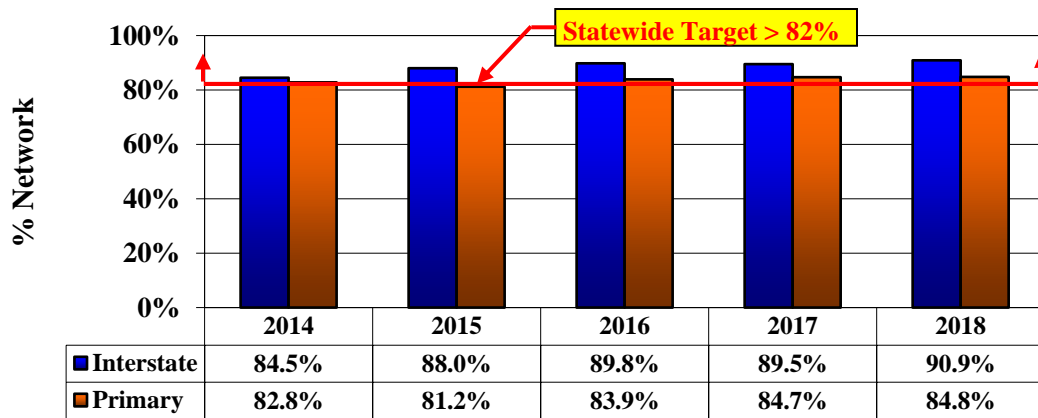
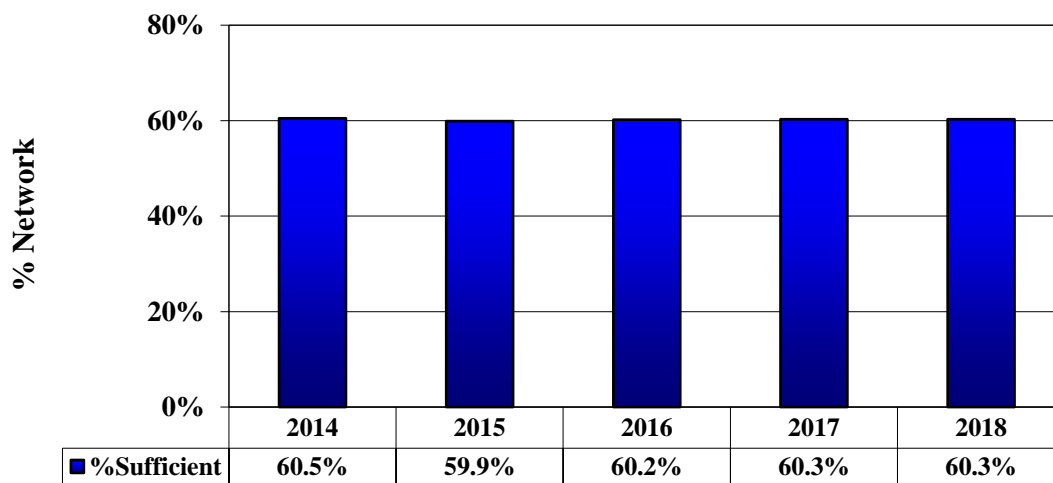


Figure XI: Trend in Percent Sufficient - Secondary



CURRENT AND FUTURE USES OF THE DATA

Pavement condition data presented in this report are used for multiple purposes – both internal and external to VDOT, including:

1. Needs-Based Budgeting. Pavement condition data are used to estimate the cost to achieve and sustain pavement performance targets, and to recommend allocation of available maintenance funds across districts. Thus, the pavement condition data are an important input into the Pavement Management System (PMS) to develop estimates of pavement maintenance and rehabilitation needs based on an optimization analysis. These needs are subsequently used for the development of the biennial maintenance budget and the work plan generated by the optimization serves as a guide to district personnel for the selection of pavement maintenance strategy for the yearly pavement maintenance schedules. Once a particular section of pavement is selected for maintenance, a detailed project level analysis is conducted to determine the specific treatment.

The data are also used to feed the maintenance decision trees to determine the unconstrained maintenance needs for the pavement assets. Unconstrained needs analysis establishes the maintenance and rehabilitation needs to appropriately correct the existing pavement conditions where available funding for work would not be considered a constraint. It provides an idea of the amount and type of work needed on the whole network. For this needs determination, each section's distress quantities and severities, and CCI are input from the condition survey data into the unconstrained decision trees⁽⁵⁾. Traffic level, structural condition, and maintenance history are also used as additional inputs to the selection of maintenance treatments wherever the data are available. In many cases the unconstrained needs are used as the first indicator of the scope of necessary maintenance which is further refined by field inspections, detailed project level analysis, and overall needs of the network.

2. Planning for Preventive Maintenance and Resurfacing. The surface distress condition data are used to identify and prioritize recommended candidate pavement sections for preventative maintenance activities. These recommendations are based on decision trees developed for the needs analysis, as described above.

The pavement data are used for selection of pavement sections and maintenance strategies for yearly pavement maintenance schedules. Automated data that provide high consistency and efficiency are used to aid in prioritizing Maintenance Resurfacing by the districts. Typically, the districts have used the data in combination with their local knowledge of pavement conditions to select pavement projects.

Information about specific distresses can be used to determine appropriate maintenance and rehabilitation actions for consideration. For example, a pavement with serious load related distress would typically require a resurface or “mill and fill” treatment, whereas a preventive maintenance treatment would be more appropriate for a pavement with primarily non-load related distresses.

3. Pavement Performance Reporting. The pavement condition data play a major role in preparation of two legislatively mandated reports. One report is the annual asset condition report required by Section 33.2-232 of the Code of Virginia. The second report, required by Section 33.2-352 each year, concerns asset management practices in the operation and maintenance of the systems of state highways.

The data are also used for tracking performance measures on the dashboard and are reported to the Commonwealth Transportation Board (CTB) yearly. The dashboard uses the condition data to display the percent of pavement in fair or better condition for each district, county and system in the form of a gauge, and also as a bar chart. The gauge points to the percent of pavement in non-deficient condition, with a tic mark to show the last year's results. All pavements on the Interstate and Primary road systems in Virginia are assessed each year and rated in one of the following categories: Excellent, Good, Fair, Poor, or Very Poor. Segments of pavement classified as Poor and Very Poor are considered deficient, all others are non-deficient. VDOT's goal, as established by the Commonwealth Transportation Board's policy, is to have a minimum of 82% of Interstate and Primary pavement; and 65% of Secondary pavement in Excellent, Good, or Fair condition.

The percent of pavement with fair or better ride quality is also displayed in a separate gauge. The performance target for sufficient ride quality is 85% for Interstate and Primary pavements, meaning that VDOT's goal is to have at least 85% of the pavements with fair or better ride quality.

4. Federal HPMS Reporting. Pavement condition data are included in VDOT's Highway Performance Monitoring System (HPMS) data submission to FHWA. This report is the basis for the federal apportionment of Virginia's share of federal funds. VDOT provides the FHWA with the length, roughness and lane-miles on state maintained roads in various functional systems for assessing and reporting highway performance. HPMS data are also used for assessing and reporting highway system performance under FHWA's strategic planning process and are the source for a substantial portion of the information published in Highways Statistics and in other FHWA publications and media. Finally, the HPMS data are widely used throughout the transportation community, including other governmental interest, business and industry, institutions of higher learning, the media and general public. More details can be found in the HPMS Field Manual⁽⁶⁾. HPMS data specifications have expanded to include requirements to report surface distress quantifications as well as additional pavement structural information for a statistical sample of highway sections. The data collected in the annual pavement condition survey will be used to meet many of the new reporting requirements.

5. Research Needs. Pavement data are made available to a variety of customers both internal and external to VDOT to meet research, analysis and planning needs. The data are also used for other purposes including determination of performance of various types

of paving materials/mix designs as well as in initial screening to identify locations for detailed project level analysis when planning maintenance and rehabilitation activities.

Accumulation of consistent and quality pavement condition data over time will also allow VDOT to predict future pavement performance trends more accurately, enabling VDOT to more efficiently manage the pavement assets. It will also help the agency measure maintenance cost effectiveness, study the influence of new construction materials on pavement performance, and can serve as a basis for future vehicle cost responsibility studies.

TABLE OF CONTENTS

EXECUTIVE SUMMARY	II
PAVEMENT DATA COLLECTION, DATA PROCESSING & QUALITY CONTROL/QUALITY ASSURANCE.....	III
STATEWIDE PAVEMENT CONDITION AND RIDE QUALITY SUMMARY	V
<i>Interstate Pavement Condition and Ride Quality by District.....</i>	<i>VII</i>
<i>Primary Pavement Condition and Ride Quality by District</i>	<i>X</i>
<i>Secondary Pavement Condition and Ride Quality by District</i>	<i>XIII</i>
<i>Statewide Pavement Deficiency Trends</i>	<i>XV</i>
CURRENT AND FUTURE USES OF THE DATA	XVI
TABLE OF CONTENTS	1
STATE OF THE PAVEMENT - 2018	3
BACKGROUND.....	3
PURPOSE AND SCOPE	4
PAVEMENT DATA COLLECTION, DATA PROCESSING & QC/QA.....	4
DISTRESS DATA ELEMENTS COLLECTED	5
QUALITY ASSURANCE.....	5
PAVEMENT INVENTORY EVALUATED.....	6
PAVEMENT CONDITION - 2018.....	6
CONDITION EVALUATION CRITERIA	6
THE CONDITION OF INTERSTATE PAVEMENT	7
<i>Asphalt Surfaced Pavement.....</i>	<i>10</i>
<i>Continuously Reinforced Concrete Pavement</i>	<i>11</i>
<i>Jointed Reinforced Concrete Pavement</i>	<i>11</i>
CONDITION OF PRIMARY PAVEMENT	12
<i>Asphalt Surfaced Pavement.....</i>	<i>14</i>
<i>Continuously Reinforced Concrete Pavement</i>	<i>15</i>
<i>Jointed Reinforced Concrete Pavement</i>	<i>16</i>
CONDITION OF SECONDARY PAVEMENT	17
<i>Plant Mix Secondary Pavement.....</i>	<i>21</i>
<i>Non-Plant Mix Secondary Pavement</i>	<i>21</i>
PAVEMENT RIDE QUALITY - 2018	22
RIDE QUALITY EVALUATION CRITERIA	22
INTERSTATE PAVEMENT RIDE QUALITY	23
PRIMARY PAVEMENTS RIDE QUALITY	25
SECONDARY PAVEMENTS RIDE QUALITY	26
USES & LIMITATIONS OF 2018 PAVEMENT CONDITION DATA.....	27
CURRENT USE OF THE DATA.....	27
<i>Pavement Needs Analysis.....</i>	<i>27</i>
<i>Planning for Preventive Maintenance and Resurfacing</i>	<i>28</i>
<i>Pavement Performance Reporting.....</i>	<i>28</i>
<i>Federal HPMS Reporting</i>	<i>29</i>
<i>Research Needs</i>	<i>29</i>

FUTURE USE OF THE DATA	29
LIMITATIONS OF THE DATA	30
REFERENCES	31
APPENDIX A: DISTRESS DATA AND FORMAT	33
APPENDIX B: DISTRIBUTION OF KEY DISTRESSES BY DISTRICTS AND SYSTEMS.....	38
APPENDIX C: PAVEMENT CONDITION BY DISTRICT AND COUNTY - 2018	46
APPENDIX D: PAVEMENT CONDITION MAPS FOR INTERSTATE AND PRIMARY SYSTEMS - 2018.....	55
APPENDIX E: PAVEMENT RIDE QUALITY BY DISTRICT AND COUNTY – 2018.....	65

STATE OF THE PAVEMENT - 2018

BACKGROUND

The Virginia Department of Transportation (VDOT) maintains the third largest public road network in this country, covering a total of about 58,607 miles consisting of about 1,120 miles of Interstate highways, 8,049 miles of Primary highways and 49,440 miles of Secondary roads. The pavement management program in Virginia began with the establishment of a pavement inventory. That phase took place in the 1970s with the manual gathering of pavement records including those of construction history and rehabilitation projects. The merging of those early pavement records and the then existing highway inventory eventually evolved into what was known in VDOT as the Highway Traffic Records Information/Inventory System (HTRIS). While, as the name implies, HTRIS was heavily oriented toward traffic engineering needs, it also was the first repository for pavement construction and rehabilitation records or pavement inventory. The Roadway Network System (RNS) created a replacement system for the aging HTRIS mainframe system. The new system now incorporates a relational database that provides universal enterprise data access, links geo-spatial data and business attributes to the roadway centerlines, and provides web accessibility to users currently unable to retrieve critical roadway data. From 2016 Roadway Inventory Management System (RIMS) is the new system of record for VDOT's road data inventory. As this initiative evolves, new business processes will be established that will streamline data editing and maintenance and will clarify and clean data and allow efficient data sharing across applications.

A second stage of pavement management activity in the state took place in the early 1980s and involved the development of a first generation pavement condition assessment methodology. This methodology, used throughout most of the 1980s and early 1990s, was a windshield survey based index procedure called the distress maintenance rating (DMR) with a rating scale of 0 to 100, with 100 being a pavement with no visual surface distress. The procedure gave consideration only to pavement surface distresses with heavy emphasis on cracking and patching. In the mid-1990s VDOT began to collect pavement distress data through the use of videotaped images. To make use of data collected from those tapes, VDOT also made interim use of the pavement condition index (PCI) defined and used by the U.S. Army Corps of Engineers⁽⁷⁾. After several trial years, the PCI was deemed too general for Virginia conditions and a VDOT specific method was developed. Briefly, that system recognizes that pavement distresses fall into two basic categories; they are either load related (caused by the application of vehicular loadings) or they are not load related (caused by the exposure of pavement elements to the environment). This realization gave rise to the development of two separate indices to describe pavement surface distresses. These are the load related distress rating (LDR) and the non-load related distress rating (NDR). These two indices also use 0 to 100 scales and are the basis for asphalt pavement surface condition evaluation in VDOT.

The advent of pavement data collection through contracted, automated means led to a need to standardize the procedures for the purposes of consistency and as a contractual instrument for bidding purposes. The document providing this standardization, *A Guide To Evaluating Pavement Distress Through The Use Of Digital Images* ⁽¹⁾, was developed and made available to vendors bidding on contract data collection.

Pavement distress condition throughout the state is crucially important information and one of the most important products of the Pavement Management Program. Dissemination of that product throughout the agency is a major reason the 1998 condition report ⁽⁸⁾, the 2002-2004 reports ⁽⁹⁾⁻⁽¹¹⁾, the 2006 report ⁽¹²⁾, and the 2008-2017 condition reports ⁽¹³⁾⁻⁽²²⁾ were assembled. One of the uses of this information is to aid in the maintenance activities of the agency. Another value of disseminating this information is to receive feedback from users on the pavement management and the asset management systems. This feedback will be used to identify and address changes that may enhance the continued implementation of the Pavement Management System.

PURPOSE AND SCOPE

The present document is more of a “fact sheet” than an in-depth research report; the intention is to provide the reader with an overall assessment of the condition of pavements throughout the Commonwealth. The condition of pavements in terms of condition states, deficient pavement network, summaries of key distresses, and ride quality are included in this report.

Previously, only the surface distress, roughness and rutting data were collected, which had limitations. Any consideration of the structural integrity of the pavements had to be deduced from the nature of the distresses (e.g., early alligator or fatigue cracking would suggest a pavement is subject to loadings in excess of its design capacity).

The surface distress data are collected and analyzed on all of the Interstate, Primary, and the hard-surfaced Secondary pavement network.

PAVEMENT DATA COLLECTION, DATA PROCESSING & QC/QA

The pavement condition data presented in this report were collected and processed by a contractor (Fugro-Roadware Inc.) using continuous digital imaging and automated crack detection technology. For data collection purposes, Fugro-Roadware uses vehicles equipped with special cameras to capture downward pavement images for crack detection, and a forward perspective view. Roughness and rutting data are simultaneously captured with the sensors mounted on the van. The data are collected at highway speeds as the vans are driven along the pavement. Downward images collected

during the survey are processed with specialized automated crack detection software for the identification of cracks. Further analysis of digital images is necessary for the identification of other distresses; such as patching, bleeding or delamination. The following sections describe the major data items that are collected, and the results of the 2018 surveys.

DISTRESS DATA ELEMENTS COLLECTED

Distresses were collected for various pavement types following the protocols specified in the distress data collection manual: “A Guide to Evaluating Pavement Distress Through the Use of Digital Images⁽¹⁾.” The data elements collected are provided in Appendix A for all of the following pavement types: continuously reinforced concrete pavement (CRCP), jointed concrete pavement (JCP) and asphalt-surfaced concrete pavement (ACP) that further includes bituminous (BIT), bituminous over jointed concrete (BOJ), and bituminous over continuously reinforced concrete (BOC) pavements. Detailed distress data in terms of extents and severities are collected and summarized for each 0.1 mile as well as for each homogeneous section. For ease of interpretation, the data are also summarized in the “ACP-INPUT” format which is used in the decision matrices to determine maintenance and rehabilitation recommendations. This is similar in format to the “windshield” data obtained while data were collected by windshield surveys before automated data collection method was adopted. The details of the various formats of the data for different types of pavements are provided in Appendix A, and the distribution of key distresses can be found in Appendix B.

QUALITY ASSURANCE

An independent QA process is an important consideration for quality data. For the 2018 data collection, the QA process began with evaluation of control sections comprised of ACP, CRCP and JCP for Interstate, Primary and Secondary systems. Image evaluations were completed on 14 control sections distributed over the system and pavement types. The control sections were used to calibrate the pavement distress rating process and also to establish the precision and bias values for the roughness and rutting measurements.

For the rutting and roughness comparison, the precision (repeatability), as specified in the terminology of ASTM E177⁽²³⁾ and the bias, based upon the average value or “ground truth”, were used for QA checks. A data-collection vehicle is considered to have passed the QA checks if it is capable of collecting rutting and roughness data within the specified repeatability limits.

For the production ratings, batches of data, including Interstate, Primary and Secondary system ACP, JCP and CRCP pavements, were delivered to, and reviewed by the Independent data Verification and Validation (IV&V) contractor. Five percent of the data delivered in each batch were randomly chosen for QA and rated independently by the IV&V contractor. A batch is considered to have passed the QA checks when the CCI index values from the production data fall within 10 points of the CCI values from

the IV&V ratings for 90% of the pavement length. In addition to the random 5% QA checks, a “high-level” data review consisted of reasonableness and a completeness check was also conducted for each delivery table. The ratings on pavement sections were also compared with the previous year’s ratings on the same sections. Any major differences in ratings were further investigated.

PAVEMENT INVENTORY EVALUATED

The 2018 automated condition surveys began in August, 2017 and were completed, including the QA evaluations, by June of 2018. The following sections summarize the inventory evaluated and the results of those surveys, including the establishment of a scale of relative condition evaluation.

The surveys were conducted in the rightmost traffic lane, usually designated lane 1 in the VDOT pavement inventory, while the tabulations, graphs, and discussions below were extended to a lane mile basis. For example, a one-mile long pavement section with three lanes in the direction of rating would be reported as three lane miles. Using the method described above, about 5,350 lane miles on Interstate and 21,182 lanes miles on Primary (26,007 lanes miles of ACP pavements and 525 lanes miles of JCP and CRCP pavements) are accounted for in 2018 surveys.

Approximately 24,453 lane miles of Secondary pavements were surveyed in 2018 (19,517 lane miles of plant mix and 4,936 lane miles of non-plant mix).

PAVEMENT CONDITION - 2018

The 2018 automated condition surveys began in August, 2017 and were completed, including the QA evaluations, by July of 2018. The following sections summarize the inventory evaluated and the results of those surveys, including the establishment of a scale of relative condition evaluation.

CONDITION EVALUATION CRITERIA

Table 1 provides a scale for evaluation for the 2018 pavement surface distress condition survey results. The index scale provided in that table is the result of experience with previous windshield surveys and reflects earlier action of the VDOT Pavement Management Engineering Team (PMET). The PMET action was a decision that pavements with a condition index of less than 60, referred to as the deficient pavements, would be evaluated further for possible higher types of maintenance and rehabilitation.

The condition state of pavement shown in Table 1 is based on CCI values. For asphalt surfaced pavements LDR and NDR are used and CCI is defined as the lower of the two values. The slab distress rating (SDR) is used for JCP pavements and the Concrete Punchout Rating (CPR) and the Concrete Distress Rating (CDR) are collected for CRCP

pavements. However, the same concept of CCI and the same scale in Table 1 apply to the latter two pavement types as well: SDR is directly equivalent to CCI for JCP pavements; and the lower of CDR and CPR is equivalent to CCI for CRCP pavements. More details about these concrete pavement condition indices are documented in another VDOT report⁽³⁾. In general, pavements rating less than 60 by either index are considered to be deficient, i.e., they need some kind of attention, more specifically, some heavier type of maintenance/rehabilitation actions. The deficient pavement in each county and district for Interstate and Primary pavements is presented in Appendix C. Appendix D shows that maps of condition of Interstate and Primary pavements.

Table 1: Pavement Condition Definition

Pavement Condition	Index Scale (CCI)
Excellent	90 and above
Good	70-89
Fair	60-69
Poor	50-59
Very Poor	49 and below

THE CONDITION OF INTERSTATE PAVEMENT

The percentage of pavements in different condition states is shown in Figure 1 for the Interstate system. It shows that more than 82 percent of the Interstate pavements are in fair or better condition on statewide basis. The distribution of Interstate condition states on a district basis is presented in Figure 2. Here all of the condition states are represented as percentages in the chart along with numerical values.

Figure 3 is a bar chart that presents the Interstate deficient lane miles in each district. This chart also presents the deficient lane miles by pavement type: Asphalt Concrete (AC), Continuously Reinforced Concrete (CRC) and Jointed Reinforced Concrete (JRC) in each district. Deficient pavements typically need some type of higher maintenance and rehabilitation treatments. Since the deficient lane miles presented in Figure 3, are part of different Interstate network sizes in different districts, the percentage of deficient pavements is presented in Figure 4. The percentage of deficient pavements equals one hundred minus the percentage of sufficient pavements.

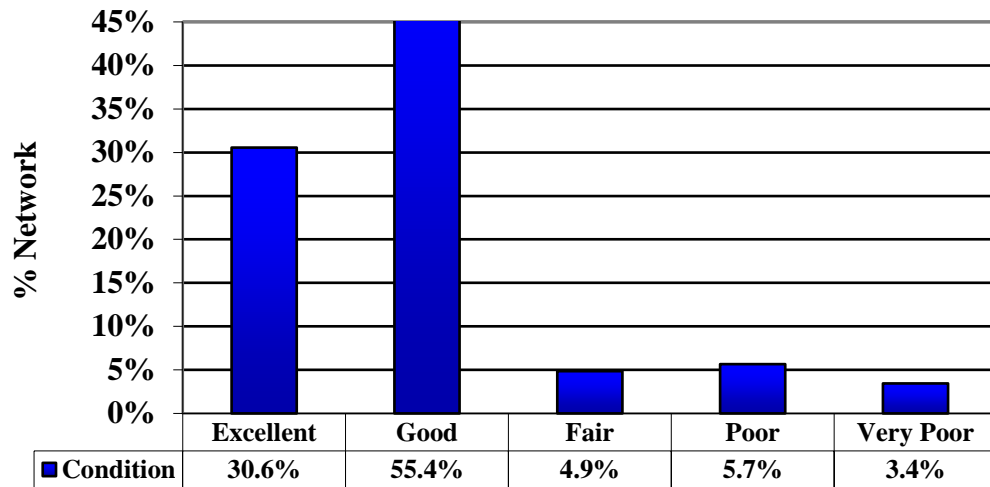
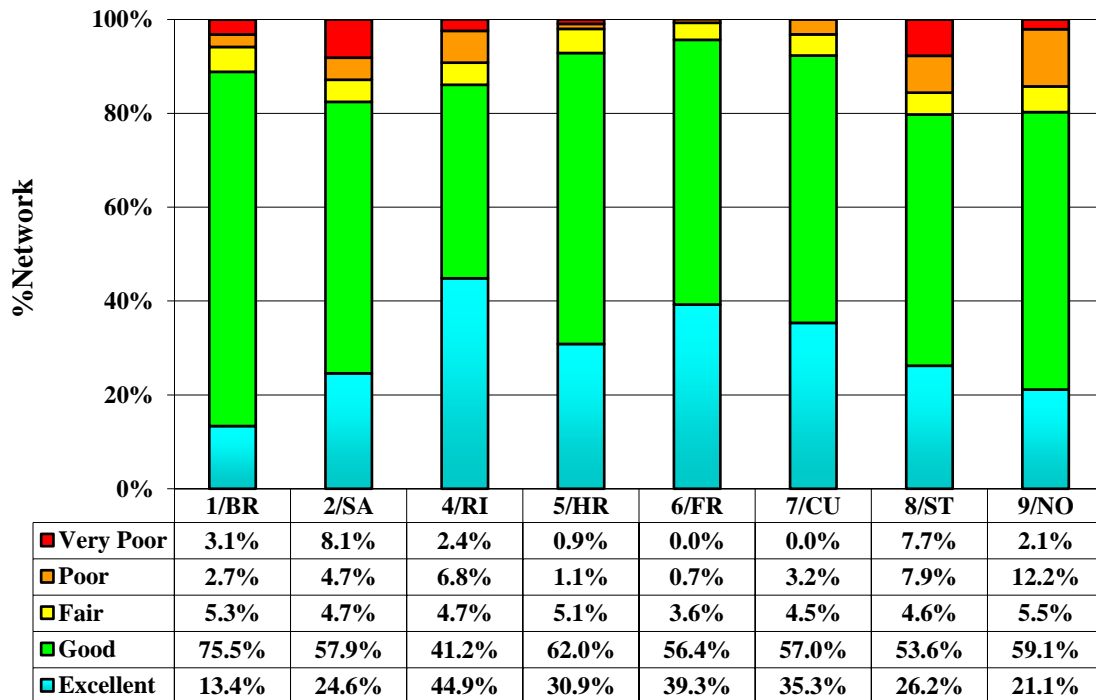
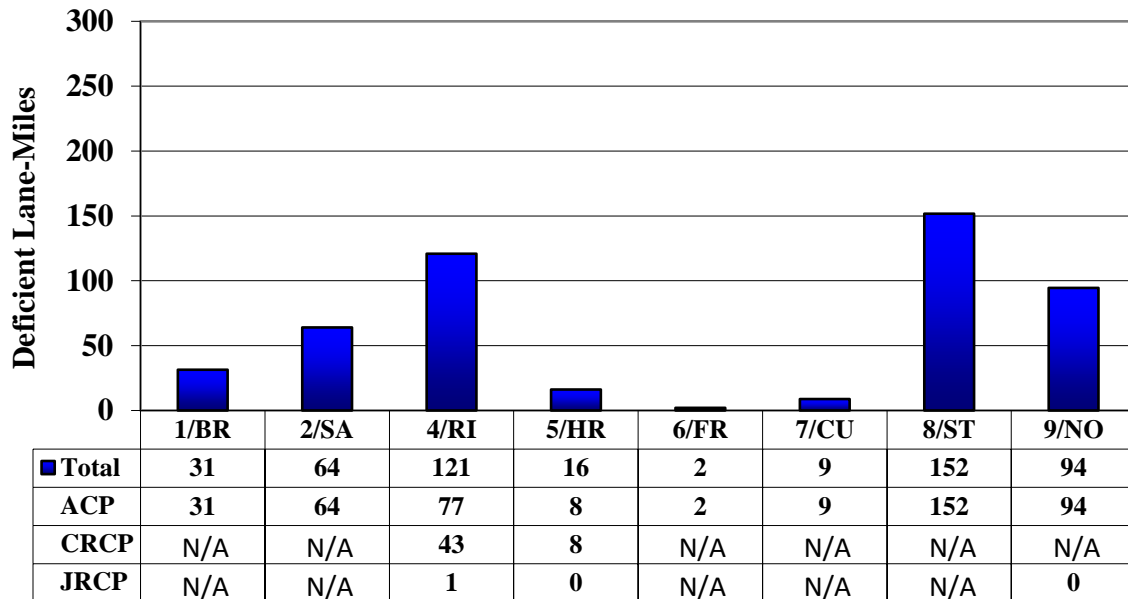
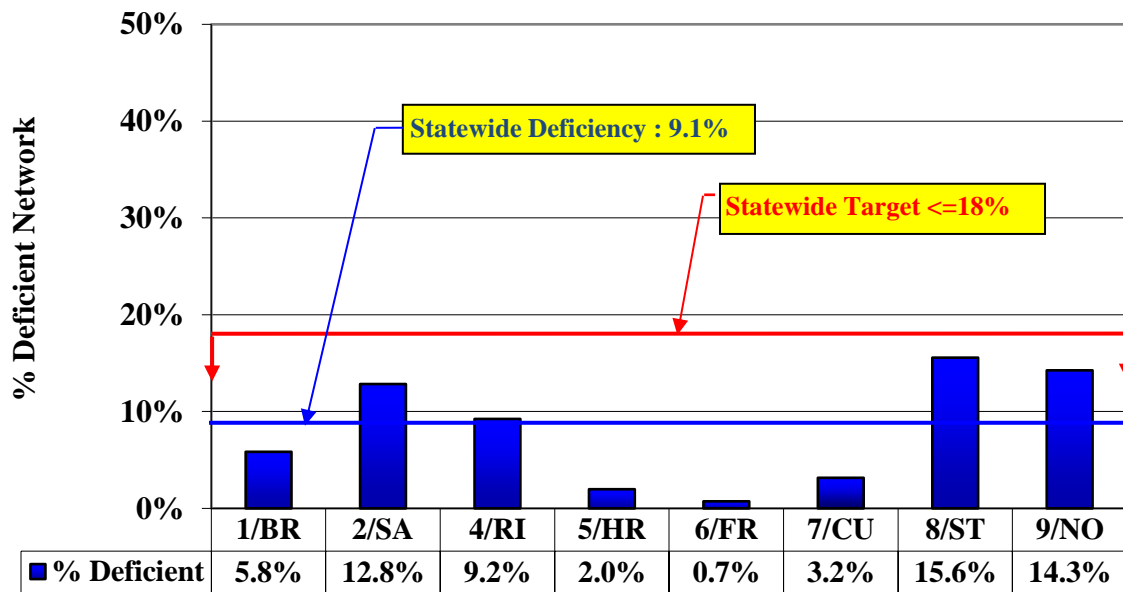
Figure 1 : Pavement Condition - Interstate**Figure 2 : Pavement Condition by District - Interstate**

Figure 3: Deficient Lane Miles by District - Interstate**Figure 4: Percent Deficiency by District - Interstate**

A performance target of a maximum of 18% deficient pavements is established for Interstate pavements. A lower value of percent deficient is preferred since it indicates lower percentage of pavements in poor and very poor condition, i.e., higher percentage of pavements in fair or better condition. In Figure 4 the statewide performance target of 18% deficient is represented by a line, and the current percent deficient of 9.1% for Interstate pavements is represented by another line. It can be seen that all the districts are below performance target of maximum 18% deficiency. District 6 shows the lowest percentage deficient, at 0.7%, whereas the highest percentage, 15.6%, is found in District 8.

ASPHALT SURFACED PAVEMENT

For asphalt surfaced pavements some of the key distresses are presented in Table 2 for each district. Alligator cracking and patching area are presented as percentages of the total area of pavement. Rutting is presented in terms of average value while transverse and longitudinal cracking are presented in terms of linear feet per lane mile. Distress types, quantities and severities are important factors in recommending maintenance and rehabilitation actions. Also, these distresses provide an indication of the type of damage to the pavements. Alligator cracking and rutting are induced by traffic loads while longitudinal and transverse cracking are typically caused by environmental effects, use of improper materials, construction deficiencies, etc.

Table 2, below, quantifies certain key distresses found on the Interstate Asphalt Pavements by district. For example, the table shows that the percentage of alligator cracking varies from a low value of 0.2% in Fredericksburg District to a high of 2.5% in Northern Virginia district. Also, it can be seen that, by district, the variation of average rutting values is relatively small from a lowest value of 0.14 inch to a highest value of 0.21 inch.

Table 2: Major Distresses on Interstate Asphalt Pavement

Key Distresses	1/BR	2/SA	4/RI	5/HR	6/FR	7/CU	8/ST	9/NO
Alligator Cracking (% total area)	2.0%	1.3%	0.8%	1.1%	0.2%	0.9%	2.1%	2.5%
Patching (% total area)	1.4%	4.0%	0.4%	1.4%	0.1%	0.7%	1.9%	0.5%
Rutting (inches)	0.16	0.19	0.17	0.16	0.21	0.16	0.17	0.14
Transverse Cracking (ft/lane mile)	392	497	374	358	533	324	727	948
Longitudinal Cracking (ft/lane mile)	3369	2174	1242	742	305	1311	2939	1716

CONTINUOUSLY REINFORCED CONCRETE PAVEMENT

For CRC pavements the percentage of asphalt patching, punchout area, PCC patching, and transverse cracking are presented in Table 3. A punchout is a serious distress that occurs in a CRC pavement constituting structural failure, and asphalt patch on concrete pavement is considered temporary in nature until a more permanent concrete patch can be applied. Punchouts, asphalt patching, and concrete patching are presented in terms of percent area of pavement. In the case of transverse cracking, both average length per mile and average spacing between transverse cracking are presented. It should be noted that the areas where cluster cracking occur are excluded for the determination of average spacing between transverse cracks. Richmond and Hampton Roads are the only two districts with CRC pavements on the Interstate system.

Table 3: Major Distresses on Interstate CRC Pavement

Key Distresses		4/RI	5/HR
Asphalt Patching (% total area)		1.0%	0.5%
Punchout (% total area)		0.1%	0.0%
PCC Patching (% total area)		16.1%	8.6%
Transverse Cracking	ft/lane mile	6,634	6,929
	Spacing (ft)	7.6	7.8

JOINTED REINFORCED CONCRETE PAVEMENT

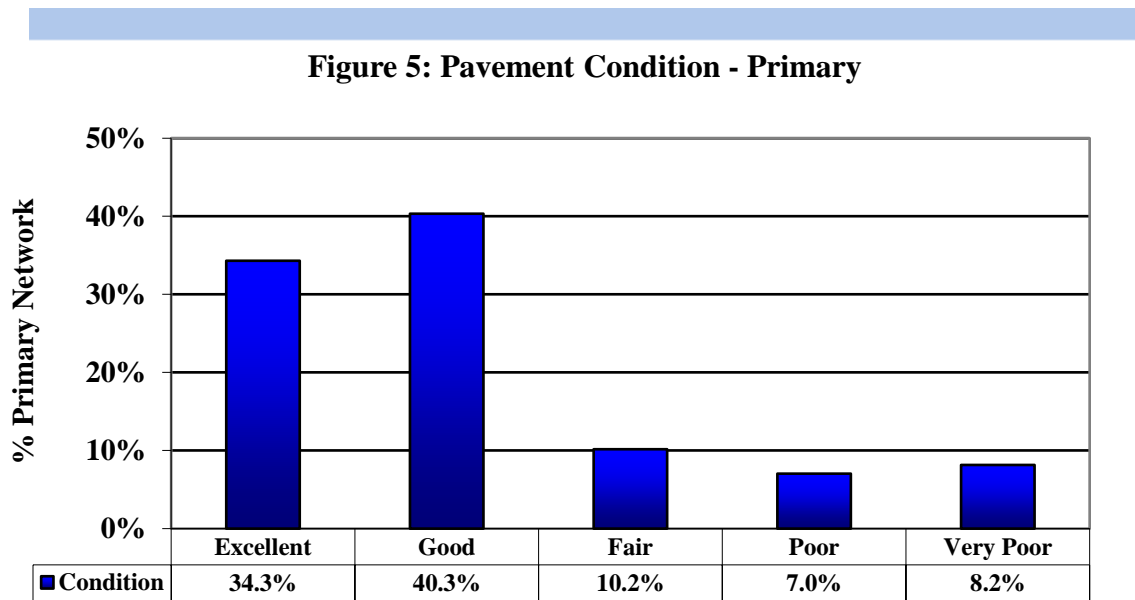
The percent of slabs of jointed concrete pavements with transverse cracks, corner breaks, PCC patching, and asphalt patching are presented in Table 4. On the Interstate system, JRC pavements are present only in Richmond, Hampton Roads, and Northern Virginia districts. Corner breaks and transverse cracks are some of the distresses that help in the determination of the required treatment type. Asphalt and PCC patching on jointed concrete pavements indicate the areas of deterioration of the slabs. Shattered slabs indicate severe damage to slabs, and they are not included in the table since the percentage of their occurrence is very low.

Table 4: Major Distresses on Interstate JRC Pavement

Key Distresses	4/RI	5/HR	9/NO
Transverse Cracking (% slabs)	9.3%	4.3%	0.8%
Corner Breaks (% slabs)	1.8%	0.4%	1.0%
PCC Patching (% slabs)	3.0%	0.8%	0.6%
Asphalt Patching (% slabs)	18.0%	2.9%	20.9%

CONDITION OF PRIMARY PAVEMENT

The statewide distribution of pavement condition on the Primary system is presented in Figure 5. It can be seen that the percentage of pavements in fair or better condition is 84.8%.



The distribution of pavement condition states on Primary system by district is shown in Figure 6.

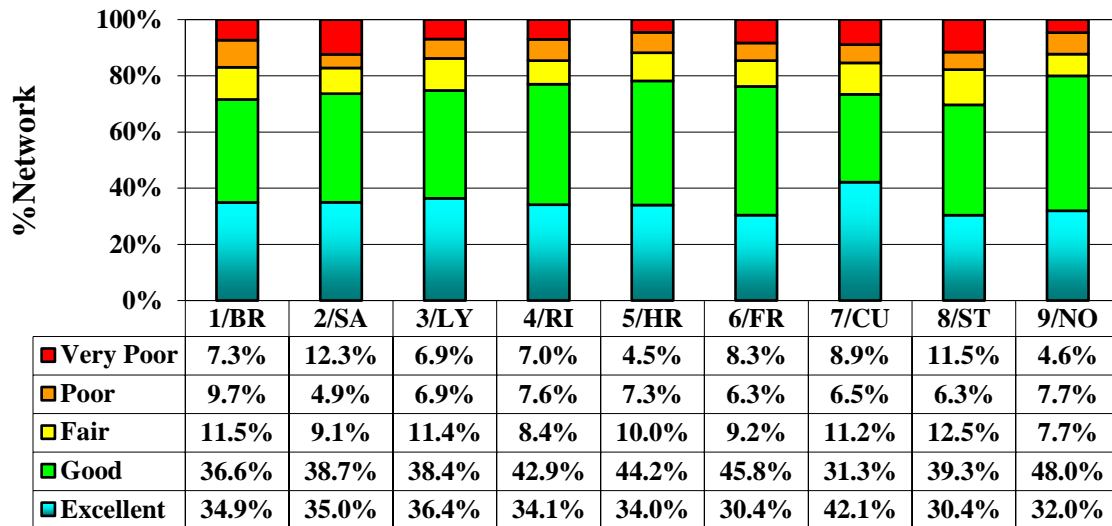
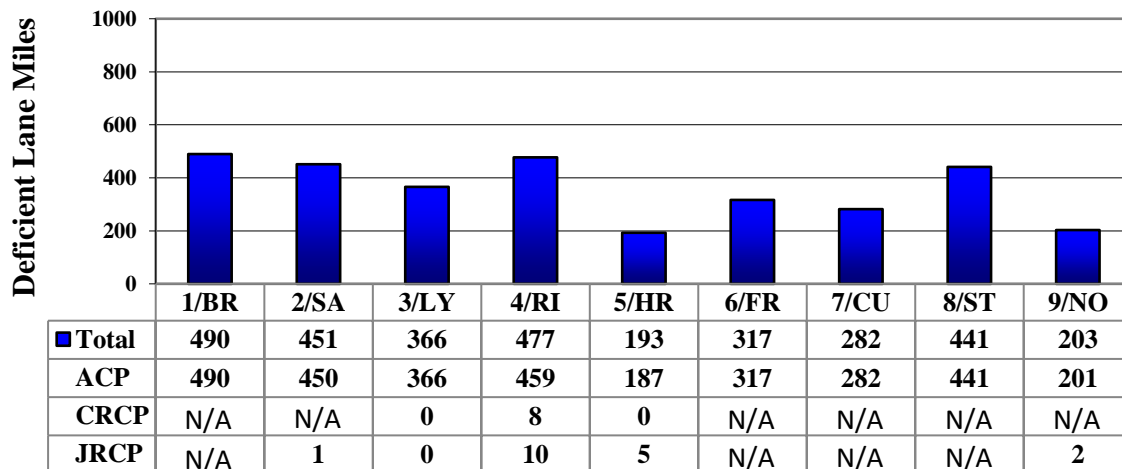
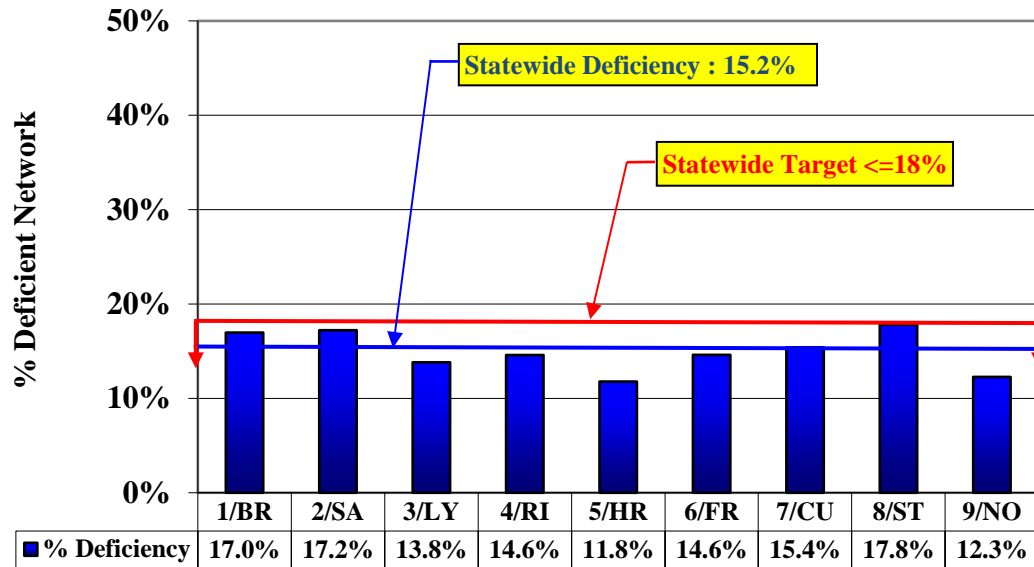
Figure 6 : Pavement Condition by District - Primary**Figure 7: Deficient Lane Miles by District - Primary**

Figure 7 presents the deficient lane miles in each district, with numerical values by pavement type. Again, each district maintains a different size network, so the total deficient lane miles vary from district to district based on both the relative size and condition of each network. For Primary pavements, Hampton Roads District has the least number of deficient lane-miles (193) while Bristol District has the highest (490).

Figure 8: Percent Deficiency by District - Primary

The percent deficient lane mile in each district is presented in Figure 8. The performance target of a maximum of 18% pavement rated as deficient as well as the statewide average percent deficiency of 15.2% are also shown in the figure. All the districts are below the target. The percentage of deficient pavements varies from a low of 11.8% in District 5 to a maximum of 17.8% in District 8.

ASPHALT SURFACED PAVEMENT

Some of the key distresses for asphalt surfaced pavements are presented in Table 5. These include percentage of alligator cracking, patching, rutting, transverse cracking and longitudinal cracking. Distress types, severities, and quantities constitute important inputs in the determination of maintenance/rehabilitation types needed.

Table 5: Major Distresses on Primary Asphalt Pavement

Key Distresses	1/BR	2/SA	3/LY	4/RI	5/HR	6/FR	7/CU	8/ST	9/NO
Alligator Cracking (% total area)	3.1%	3.3%	3.5%	3.3%	4.1%	3.9%	3.7%	3.8%	3.2%
Patching (% total area)	2.7%	1.5%	1.4%	1.1%	0.8%	0.9%	1.2%	3.0%	1.1%
Rutting (inches)	0.14	0.15	0.14	0.15	0.18	0.14	0.14	0.13	0.14
Transverse Cracking (ft/lane mile)	663	1429	1461	1225	1385	1538	1019	1048	1058
Longitudinal Cracking (ft/lane mile)	902	1106	751	918	1003	938	688	965	1238

CONTINUOUSLY REINFORCED CONCRETE PAVEMENT

Some of the key distresses in CRC pavements include: asphalt patching, punchouts, PCC patching, and transverse cracking and are presented in Table 6. In the case of transverse cracking, both the average length per mile and average spacing between the cracks are presented. For the determination of average spacing between the transverse cracks, the area of cluster cracking is excluded. Smaller quantities of transverse cracks per lane mile imply that the spacing between the cracks would be larger. Lynchburg, Richmond, and Hampton Roads are the only three districts with CRC pavements on the Primary system.

Table 6: Major Distresses on Primary CRC Pavement

Key Distresses		D3 LY	D4 RI	D5 HR
Asphalt Patching (% total area)		0.0%	0.0%	0.0%
Punchout (% total area)		0.1%	0.3%	0.2%
PCC Patching (% total area)		0.0%	4.4%	1.5%
Transverse Cracking	ft/lane mile	9,828	8,906	8,150
	Spacing (ft)	5.9	5.9	7.0

JOINTED REINFORCED CONCRETE PAVEMENT

The percentage of slabs with transverse cracks, corner breaks, PCC patching, and asphalt patching are presented in Table 7. As expected, it can be seen from the tables that transverse cracking and PCC patching are common distresses on JRC pavements. Only five districts have JRC pavements on the Primary system.

Table 7: Major Distresses on Primary JRC Pavement

Key Distresses	D2 SA	D3 LY	D4 RI	D5 HR	D9 NO
Transverse Cracking (% slabs)	62.5%	25.0%	5.7%	8.7%	13.3%
Corner Breaks (% slabs)	0.0%	0.5%	0.2%	1.6%	5.0%
PCC Patching (% slabs)	89.6%	10.2%	0.8%	7.5%	19.3%
Asphalt Patching (% slabs)	22.9%	1.6%	2.1%	1.8%	26.7%

CONDITION OF SECONDARY PAVEMENT

Figure 9 shows the statewide condition distribution of the Secondary network while Figure 10 presents the distribution on district basis.

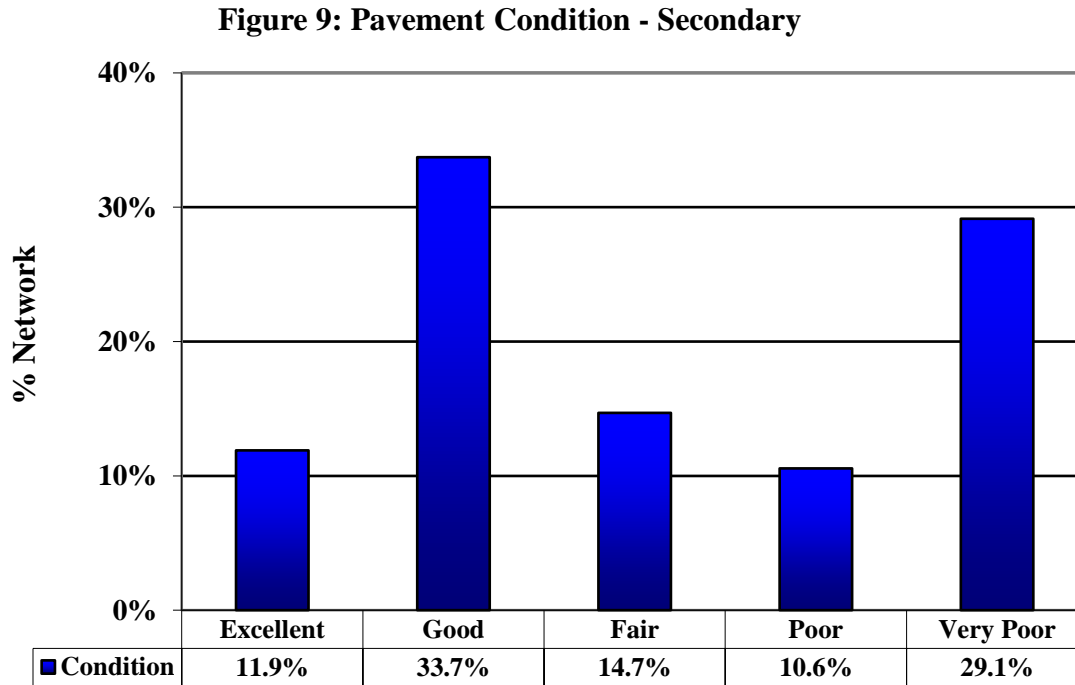


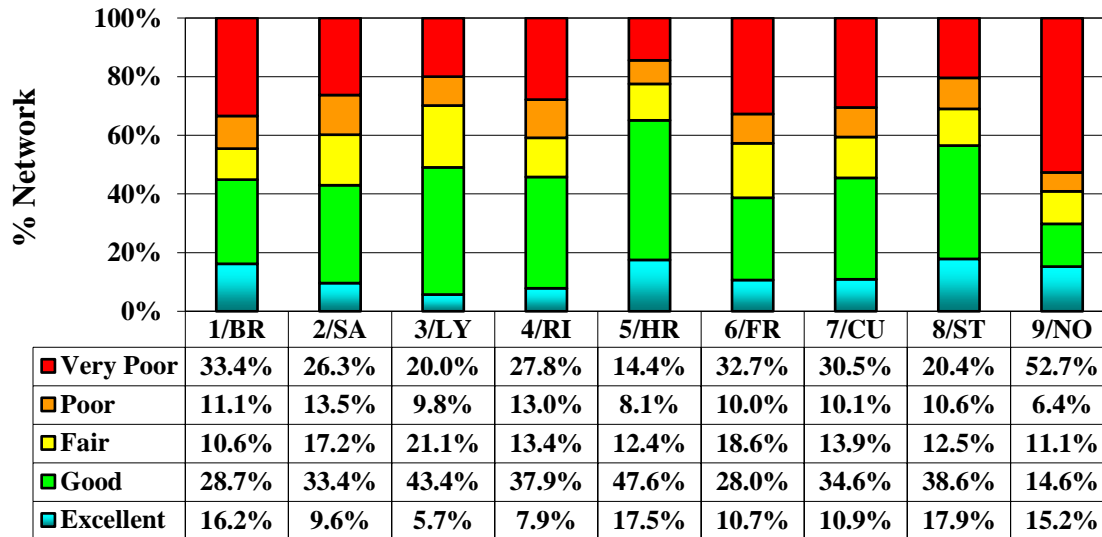
Figure 10 : Pavement Condition by District - Secondary

Figure 11 shows the number of lane-miles surveyed in each district as well as the number of lane-miles rated as ‘deficient’. Figure 12 represents the percent deficient in terms of lane miles surveyed. Based on these figures, Northern Virginia District has the highest percentage of its Secondary network rated as deficient while Hampton Roads District has the lowest.

Within the Secondary network, the rated lane miles of plant mix surfaces and non-plant mix surfaces are shown in Figure 13. Some districts have more plant mix lanes miles while non-plant mix lane miles are more in other districts.

The percentage of deficient Secondary plant mix and non-plant mix lane miles are presented in Figure 14. In general, it can be seen that the percent deficient of non-plant mix pavements is larger than that of plant mix. Richmond, Hampton Roads, and Culpeper districts show lower non-plant mix percent deficient than plant mix percent deficient.

Figure 11: Surveyed and Deficient Lane Miles by District - Secondary

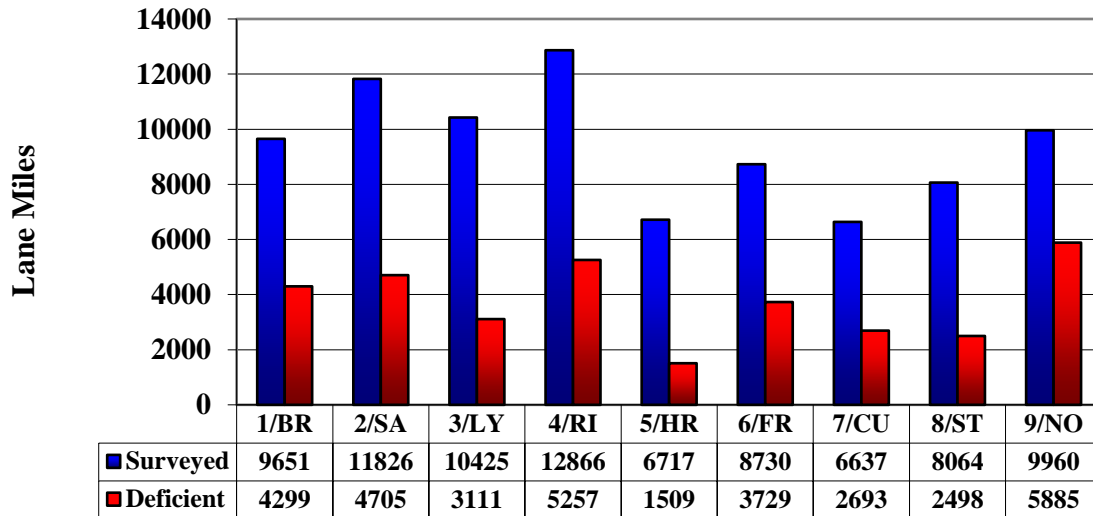


Figure 12: Percent Deficiency by District - Secondary

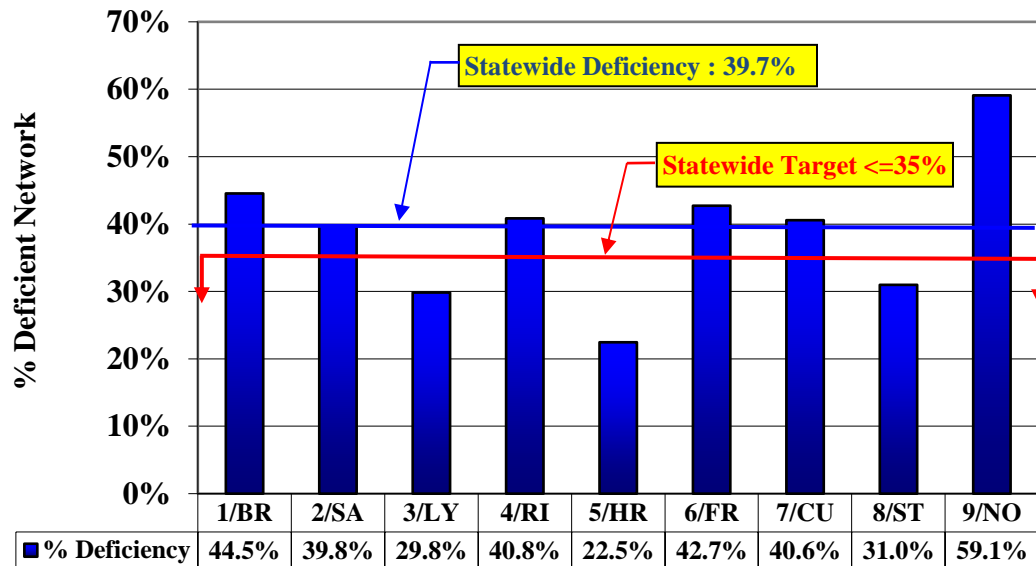


Figure 13: Surveyed Lane Miles - Secondary with Plant Mix (PM) & Non-Plant Mix (NPM) Surface

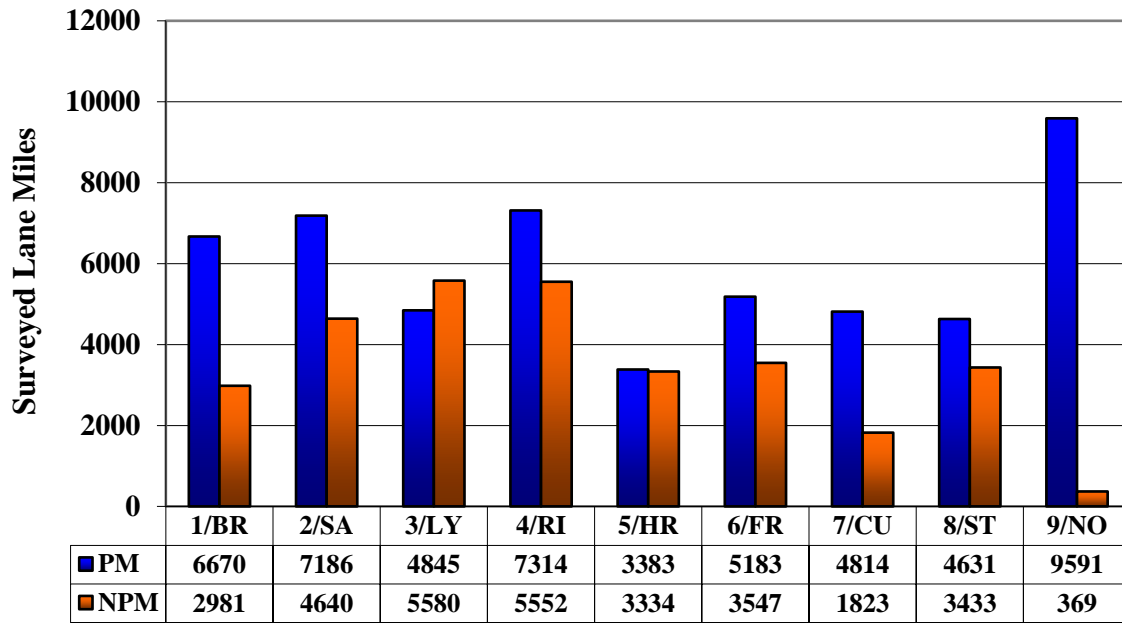
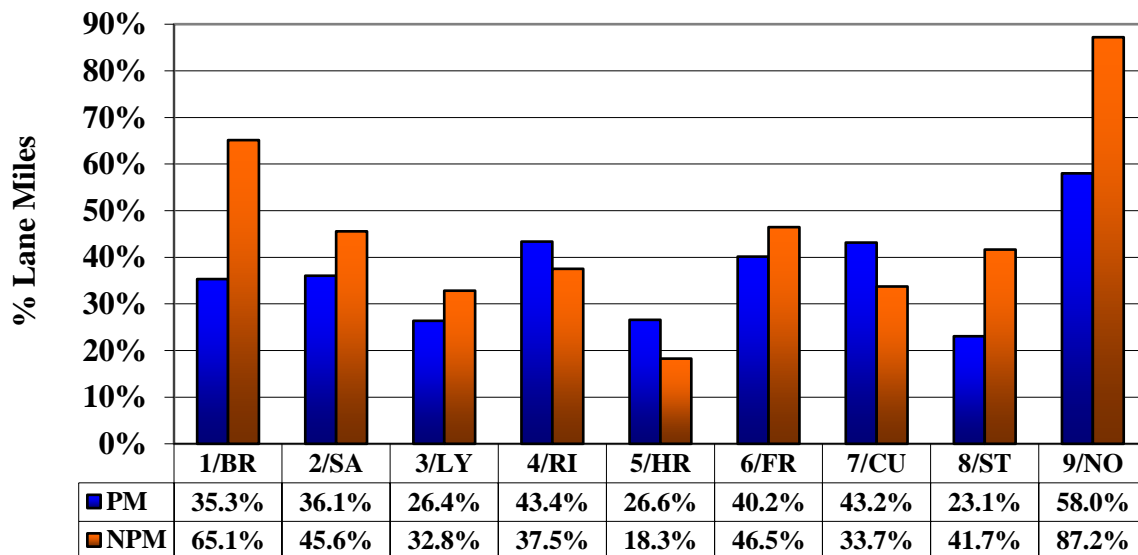


Figure 14: Percent Deficiency by District and Pavement Type - Secondary



PLANT MIX SECONDARY PAVEMENT

Some of the key distress types are shown in Table 8 for plant mix surfaced pavements on the Secondary network.

Table 8: Major Distresses on PM Surfaced Pavement

Key Distresses	D1 BR	D2 SA	D3 LY	D4 RI	D5 HR	D6 FR	D7 CU	D8 ST	D9 NO
Alligator Cracking (% total area)	3.7%	3.4%	3.3%	4.8%	3.8%	5.3%	5.3%	2.4%	6.3%
Patching (% total area)	4.9%	4.5%	3.4%	3.8%	0.7%	2.3%	3.0%	4.5%	2.6%
Rutting (inches)	0.17	0.19	0.21	0.17	0.16	0.15	0.17	0.18	0.13
Transverse Cracking (ft/lane mile)	787	1183	1150	1770	1365	1876	1734	587	2927
Longitudinal Cracking (ft/lane mile)	1377	829	711	1240	904	1312	1254	569	2352

NON-PLANT MIX SECONDARY PAVEMENT

Some of the key distress types are shown in Table 9 for non-plant mix surfaced Secondary pavements.

Table 9: Major Distresses on NPM Secondary Pavement

Key Distresses	D1 BR	D2 SA	D3 LY	D4 RI	D5 HR	D6 FR	D7 CU	D8 ST	D9 NO
Alligator Cracking (% total area)	4.8%	3.0%	2.6%	3.2%	2.3%	4.9%	3.5%	2.4%	9.4%
Patching (% total area)	9.7%	6.2%	5.6%	5.7%	1.4%	3.6%	3.4%	9.0%	4.1%
Rutting (inches)	0.25	0.25	0.25	0.22	0.21	0.24	0.23	0.24	0.17
Transverse Cracking (ft/lane mile)	876	800	665	928	583	1583	851	462	3759
Longitudinal Cracking (ft/lane mile)	1719	856	664	712	508	993	816	544	3068

PAVEMENT RIDE QUALITY - 2018

RIDE QUALITY EVALUATION CRITERIA

Pavement roughness is generally defined as an expression of the aggregation of irregularities in the pavement surface per linear mile that adversely affect the ride quality of a vehicle (and thus the user). Roughness is an important pavement characteristic because it affects not only ride quality but also vehicle delay costs, fuel consumption and maintenance costs; also, the general public perception of a good road is one that provides a smooth ride. Ride quality is expressed in terms of International Roughness Index (IRI) measured in inches/mile.

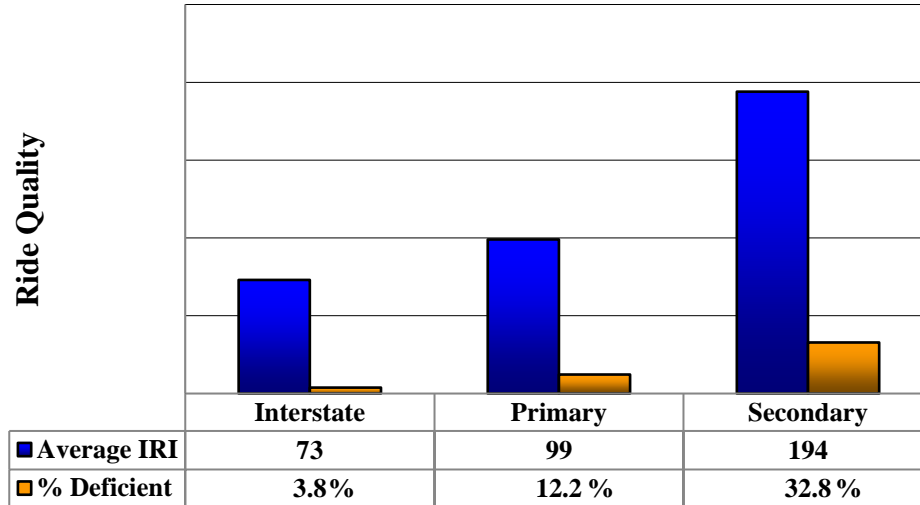
Table 10 contains two IRI scales used for evaluation of the 2018 pavement ride quality survey: one set for Interstate and Primary highways, and the other for Secondary roads. It needs to be pointed out that ranges of IRI values corresponding to qualitative descriptors of ride quality were built upon similar categories promulgated by FHWA ⁽⁴⁾ and incorporated consensuses from VDOT pavement experts regarding what thresholds were considered appropriate to represent acceptable roughness levels on Virginia highways. Pavements with poor and very poor ride quality are said to have deficient ride quality. The distribution of deficient ride quality in different counties is presented in Appendix E.

Table 10 : Pavement Ride Quality Definition

Ride Quality Category	IRI Rating (inch/mile)	
	Interstate & Primary	Secondary
Excellent	< 60	< 95
Good	60 to 99	95 to 169
Fair	100 to 139	170 to 219
Poor	140 to 199	220 to 279
Very Poor	≥ 200	≥ 280

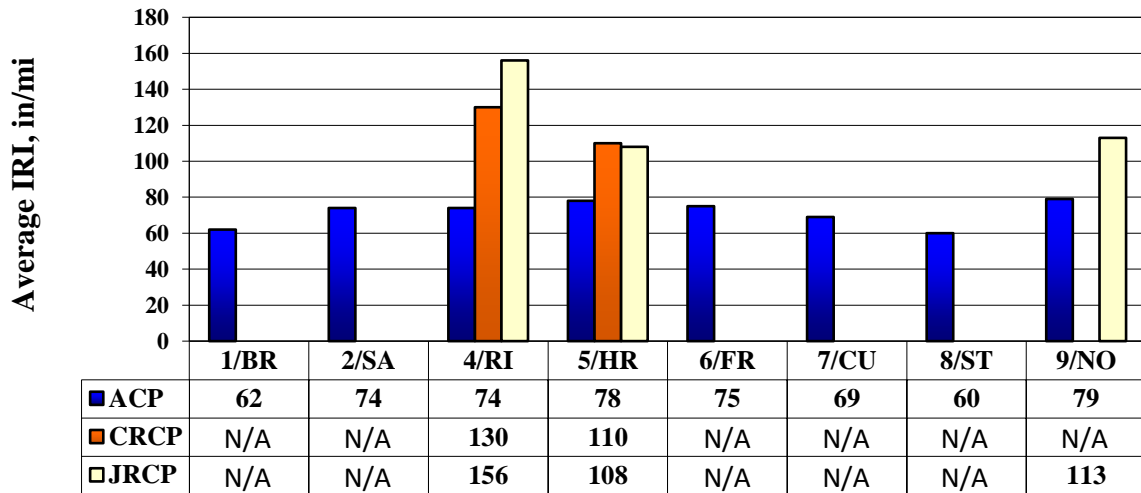
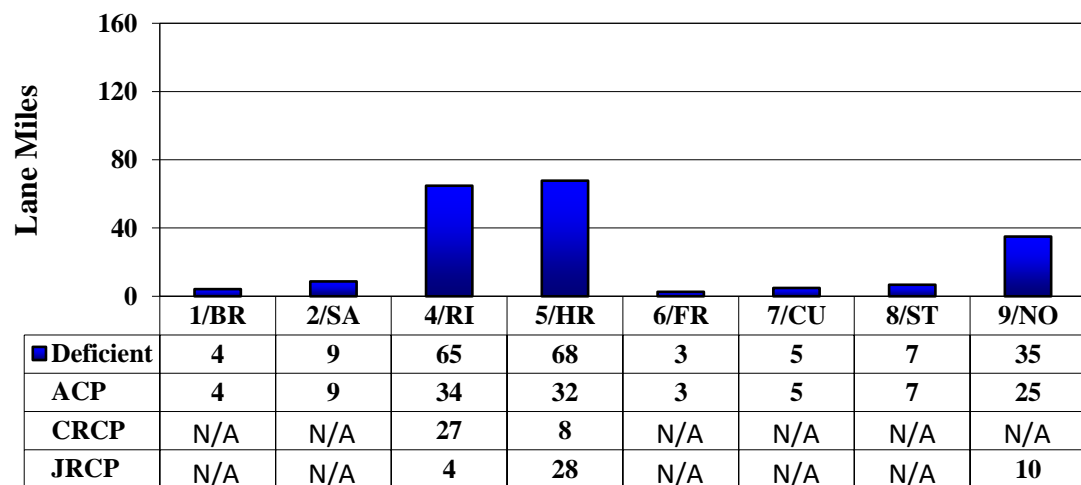
The average IRI values for Interstate, Primary and Secondary system are presented in Figure 15, along with the percentage of pavement network with deficient ride quality, i.e., the ride quality is poor or very poor. On Interstate, Primary, and Secondary pavements the data are collected on the entire network.

**Figure 15: Statewide Ride Quality
(Interstate, Primary & Secondary Pavement)**



INTERSTATE PAVEMENT RIDE QUALITY

For Interstate pavements, the average IRI values are presented in Figure 16. It can be seen that typically average IRI values for AC pavements are the lower than for CRC and for JRC pavements. Lane miles of deficient ride quality by pavement type are presented in Figure 17.

Figure 16: Average IRI by District and Pavement Type - Interstate**Figure 17: No. of Deficient Lane Miles Due to Ride Quality by Pavement Type - Interstate**

PRIMARY PAVEMENTS RIDE QUALITY

Figure 18 and Figure 19 display the average IRI values and deficient ride quality by pavement type, respectively. Again, typically, the AC pavements have IRI values lower than CRC or JRC pavements.

Figure 18: Average IRI by District and Pavement Type - Primary

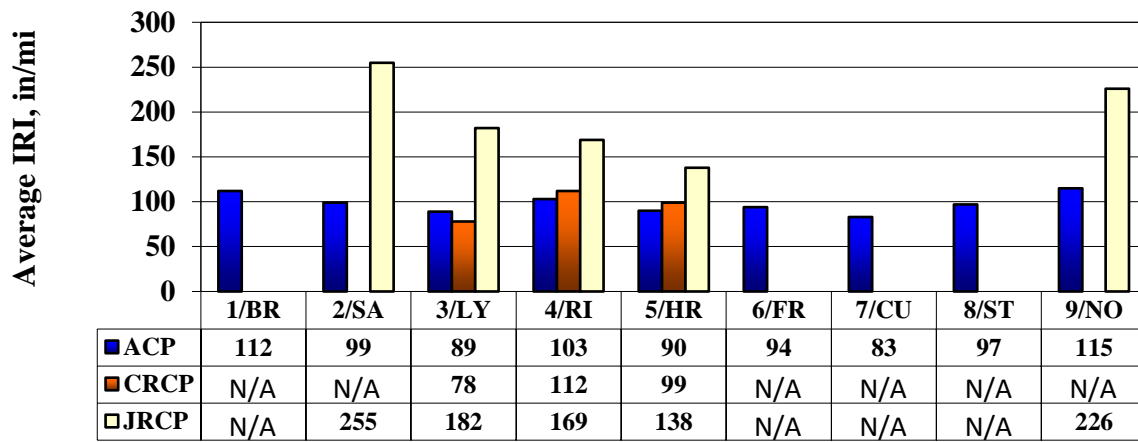
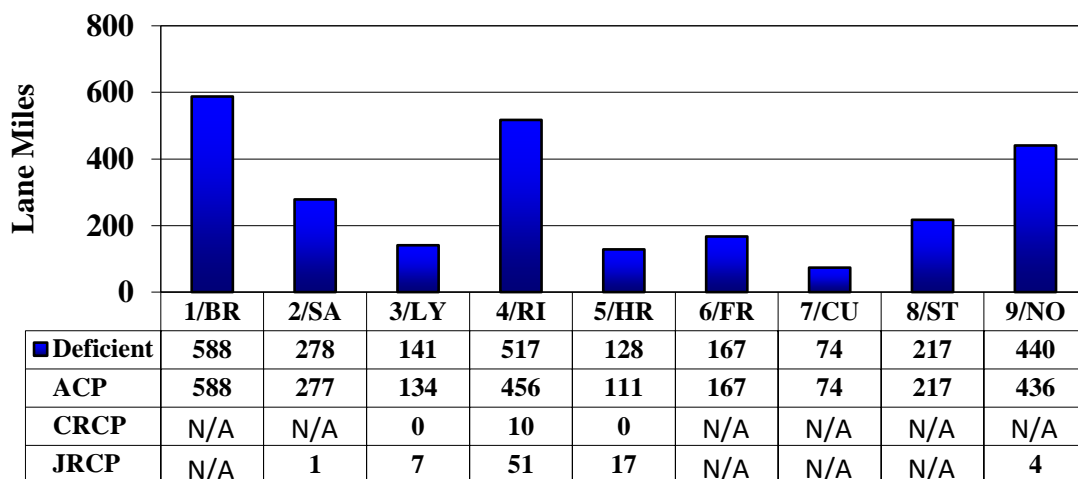


Figure 19: No. of Deficient Lane Miles Due to Ride Quality by Pavement Type - Primary



SECONDARY PAVEMENTS RIDE QUALITY

Figure 20 displays the average IRI by pavement type for Secondary pavements. It can be seen that the IRI values are higher for non-plant mix than for plant mix Secondary pavements. Figure 21 displays the deficient ride quality lane miles for plant mix and non-plant mix.

Figure 20: Average IRI by District and Pavement Type - Secondary

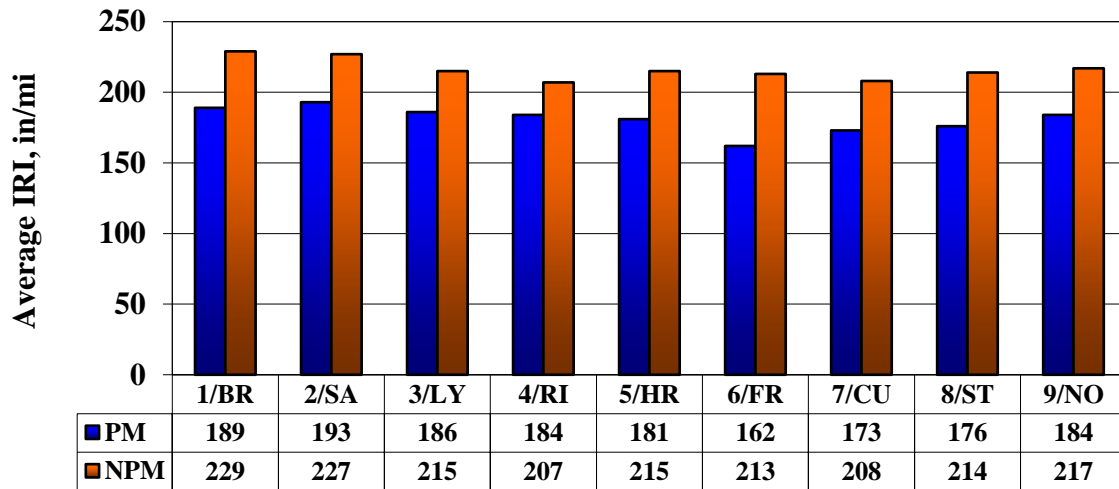
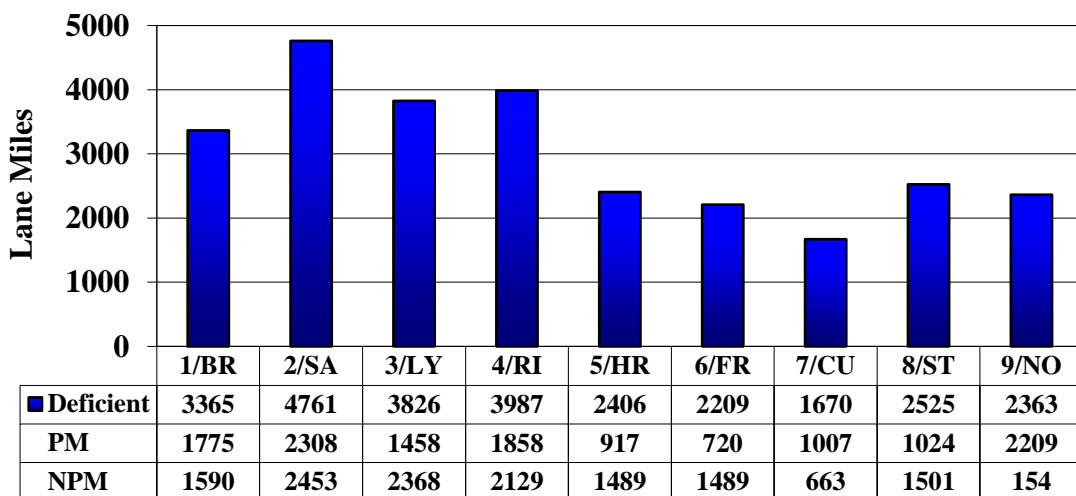


Figure 21 : No. of Deficient Lane Miles Due to Ride Quality by Pavement Type - Secondary



USES & LIMITATIONS OF 2018 PAVEMENT CONDITION DATA

This section describes a few of the uses of this data as well as some of the data limitations. In addition, future uses of this data are described here.

CURRENT USE OF THE DATA

Pavement condition data presented in this report are used by VDOT Central Office and District staff to plan, budget, prioritize and schedule pavement maintenance and rehabilitation work. Data are also used for internal and external performance reporting; and are made available to pavement researchers, safety planners and others within and external to VDOT. Major uses of this information are described below.

PAVEMENT NEEDS ANALYSIS

The pavement condition data are an important input into the Pavement Management System (PMS) to develop estimates of pavement maintenance and rehabilitation needs based on an optimization analysis. These needs are subsequently used for the development of the biennial maintenance budget and the work plan generated by the optimization serves as a guide to district personnel for the selection of pavement maintenance strategy for the yearly pavement maintenance schedules. Once a particular section of pavement is selected for maintenance, a detailed project level analysis is conducted to determine the specific treatment.

To develop the Interstate and Primary pavement needs, the pavement condition data are loaded into the Pavement Management System (PMS) which then optimizes the selection of pavement maintenance activities on the Interstate and Primary network. These needs estimates are provided through a process called multi-constraint optimization analysis, which develops an optimal work plan (a series of pavement maintenance activities applied to specific sections on the total network) to achieve a single objective (minimizing cost) against multiple condition-based constraints (performance targets) in a given year of the total six year analysis.

The data are also used to feed the maintenance decision trees to determine the unconstrained maintenance needs for the pavement assets. Unconstrained needs analysis establishes the maintenance and rehabilitation needs to appropriately correct the existing pavement conditions where funding would not be considered a constraint. It provides an idea of the amount and type of work needed on the whole network. For the determination of the needed treatment for a particular section the decision trees are used with distress quantity and severity, and condition index as input from the condition survey data⁽⁵⁾. Also, traffic level, structural condition, and maintenance history are provided as additional inputs wherever these are available for the selection of treatment. Unconstrained needs are also used in many cases as the first indicator of the needed treatment which is further refined by field inspections, detailed project level analysis, overall needs of the network and available budget.

PLANNING FOR PREVENTIVE MAINTENANCE AND RESURFACING

The surface distress condition data have been used to identify recommended candidate pavement sections for preventative maintenance activities. These recommendations are based on decision trees developed for the needs analysis, as described above.

The pavement data are used for selection of pavement sections and maintenance strategies for yearly pavement maintenance schedule. Automated data that provide high consistency and efficiency have been used to aid in prioritizing Maintenance Resurfacing by the districts. Typically, the districts have used the data in combination with their local knowledge of pavement conditions to select pavement projects.

Information about specific distresses can be used to determine appropriate maintenance and rehabilitation actions for consideration. For example, a pavement with serious load related distress would typically require a resurface or “mill and fill” treatment, whereas a preventive maintenance treatment would be more appropriate for a pavement with primarily non-load related distresses.

PAVEMENT PERFORMANCE REPORTING

The pavement condition data play a major role in preparation of two legislatively mandated reports. One report is the annual infrastructure condition report required by Section 33.2-232 of the Code of Virginia. The second biennial report required by Section 33.2-352 of the Code of Virginia, concerns asset management practices.

The data are also used for tracking performance measures on the dashboard and are reported to the Commonwealth Transportation Board (CTB) yearly. The dashboard uses the condition data to display the percent of pavement in fair or better condition for each district, county and system in the form of a gauge, and also as a bar chart. The gauge points to the percent of pavement in non-deficient condition, with a tic mark to show the last year's results. All pavements on the Interstate and Primary road systems in Virginia are assessed each year and rated in one of the following categories: Excellent, Good, Fair, Poor, or Very Poor. Segments of pavement classified as Poor and Very Poor are considered deficient, all others are non-deficient. The lower portion of the screen shows a bar chart with each VDOT District represented. The bars show the percentage of pavement in each District that is in Fair or better condition. If a District is selected using data filters then the bar chart shows each county in the District, and that county's percentage of non-deficient pavement. VDOT's goal is to have a minimum of 82% of Interstate and Primary pavement in Excellent, Good, or Fair condition.

The percent of pavement with fair or better ride quality is also displayed in a separate gauge. Performance target for deficient ride quality is 85% for Interstate and Primary pavements, i.e., VDOT's goal is to have at least 85% of the pavements with fair or better ride quality. Thus the dashboard presents the information in an easy to understand form with the users being able to obtain information of the current

performance and previous year's performance against the performance target. These data are available on the internet, and can be viewed by general public.

FEDERAL HPMS REPORTING

Pavement condition data are included in VDOT's Highway Performance Monitoring System (HPMS) data submission to FHWA. This report is the basis for the federal apportionment of Virginia's share of federal funds. VDOT provides the FHWA with the length, roughness and lane-miles on state maintained roads in various functional systems for assessing and reporting highway performance. HPMS data are also used for assessing and reporting highway system performance under FHWA's strategic planning process and are the source for a substantial portion of the information published in Highways Statistics and in other FHWA publications and media. Finally, the HPMS data are widely used throughout the transportation community, including other governmental interest, business and industry, institutions of higher learning, the media and general public. More details can be found in the HPMS Field Manual⁽⁶⁾.

Current HPMS requirements are that roughness data, quantified to the nearest inch/mile using the international roughness index (IRI), are reported for all pavement on the National Highway System (which includes the Interstate System) and on all Principal Arterials. IRI data are also required for sample sections on Minor Arterials. The pavement condition data are the primary source for the IRI data; however, VDOT Materials Division's Non-Destructive Testing Unit collects the IRI data for sample sections that are not a part of the annual pavement condition surveys.

HPMS data specifications will expand to include requirements to report surface distress quantifications as well as additional pavement structural information for a statistical sample of highway sections. The data collected in the annual pavement condition survey will be used to meet many of the new reporting requirements.

RESEARCH NEEDS

The pavement condition data are used to satisfy various internal and external research needs. Frequently, there are requests for pavement condition data from various divisions within VDOT, and also research units associated with VDOT.

FUTURE USE OF THE DATA

Accumulation of consistent, quality condition data over time allows VDOT to better understand the cost-effectiveness of different pavement treatment strategies. This information enables VDOT to make investment decisions that maximize pavement life and optimize use of scarce resources. Pavement performance models are a key element of VDOT's pavement management system – they are used to predict future pavement conditions and calculate the benefits of alternative treatment strategies. Historical condition data provide the basis for improvements to these performance models which in turn enhance the accuracy, reliability and usefulness of the system's recommendations. Historical data also provide a rich base of information for research into maintenance cost

effectiveness, the influence of new construction materials and techniques on pavement performance, and the performance of pavements under different traffic loading and environmental conditions. Pavement performance research results may also be used for vehicle cost responsibility studies and the establishment of licensing fees related to pavement damage.

LIMITATIONS OF THE DATA

While surface condition data are very helpful in project selection they cannot be the only source of information used to determine what actually should be done to a pavement. Determining the appropriate action for a pavement that is not performing as well as desired may require projected traffic loads, maintenance history of the pavement, the analysis of cores, trenching, and the use of non-destructive testing procedures. In other words, surface distress (especially premature) might indicate the need for a more detailed investigation or testing. For example, excessive early fatigue cracking suggests structural inadequacy, but does not indicate where the inadequacy lies (foundation, base, surface, etc.) warranting the need for detailed investigation.

REFERENCES

1. *A Guide to Evaluating Pavement Distress Through the Use of Digital Images*, Virginia Department of Transportation, Asset Management Division, March, 2014.
2. McGhee, K H. *Development and Implementation of Pavement Condition Indices for the Virginia Department of Transportation, Phase I: Flexible Pavement*. Virginia Department of Transportation, Maintenance Division, Sept. 2002.
3. McGhee, K H., Habib, Affan and Tanveer Chowdhury. 2002. *Development of Pavement Condition Indices for the Virginia Department of Transportation: Phase II – Rigid Pavements*. Virginia Department of Transportation, Maintenance Division.
4. *2002 Conditions and Performance Report - Chapter 3: System Conditions*. FHWA, U.S. Department of Transportation, accessed 11/22/2016.
<http://www.fhwa.dot.gov/policy/2002cpr/ch3b.cfm>
5. *Supporting Document for the Development and Enhancement of the Pavement Maintenance Decision Matrices Used in the Needs-Based Analysis*, Maintenance Division, 2011.
6. *HPMS Field Manual*, U.S. Department of Transportation, Federal Highway Administration Office of Highway Policy Information, March, 2014.
7. *Pavement Maintenance Management for Roads and Streets Using the PAVER System*, U.S. Army Corps of Engineers, Washington, D. C., 1990.
8. *Condition of the Pavement – 1998, Primary and Interstate Highways*, Virginia Department of Transportation, Maintenance Division, 1999.
9. *State of the Pavement – 2002, Interstate and Primary Highways*, Virginia Department of Transportation, Asset Management Division, Pavement Management Program, 2002.
10. *State of the Pavement – 2003, Interstate and Primary Highways*, Virginia Department of Transportation, Asset Management Division, Pavement Management Program, 2003.
11. *State of the Pavement – 2004, Interstate and Primary Highways*, Virginia Department of Transportation, Asset Management Division, Pavement Management Program, 2004.
12. *State of the Pavement – 2006, Interstate and Primary Highways*, Virginia Department of Transportation, Asset Management Division, Pavement Management Program, 2006.
13. *State of the Pavement – 2008*, Virginia Department of Transportation, Asset Management Division, Pavement Management Program, 2008.

14. *State of the Pavement – 2009*, Virginia Department of Transportation, Maintenance Division, Pavement Management Program, 2009.
15. *State of the Pavement – 2010*, Virginia Department of Transportation, Maintenance Division, Pavement Management Program, 2010.
16. *State of the Pavement – 2011*, Virginia Department of Transportation, Maintenance Division, Pavement Management Program, 2011.
17. *State of the Pavement – 2012*, Virginia Department of Transportation, Maintenance Division, Pavement Management Program, 2012.
18. *State of the Pavement – 2013*, Virginia Department of Transportation, Maintenance Division, Pavement Management Program, 2013.
19. *State of the Pavement – 2014*, Virginia Department of Transportation, Maintenance Division, Pavement Management Program, 2014.
20. *State of the Pavement – 2015*, Virginia Department of Transportation, Maintenance Division, Pavement Management Program, 2015.
21. *State of the Pavement – 2016*, Virginia Department of Transportation, Maintenance Division, Pavement Management Program, 2016.
22. *State of the Pavement – 2017*, Virginia Department of Transportation, Maintenance Division, Pavement Management Program, 2017.
23. ASTM E 177 – 13, *Standard Practice for Use of the Terms Precision and Bias in ASTM Test Methods*.

APPENDIX A: DISTRESS DATA AND FORMAT

Table A1. Distress Data and Format for Asphalt Surfaced Pavement

Description	Field Name	Pavement Type	Units	Format	Comments
IRI Left WP	NIRI_L	BIT/BOJ/BOC	inches/mile	999	Save profile data - RoadRuf, Maximum IRI is 500 inches per mile
IRI Right WP	NIRI_R	BIT/BOJ/BOC	inches/mile	999	Save profile data - RoadRuf, Maximum IRI is 500 inches per mile
IRI Average	NIRI_AVG	BIT/BOJ/BOC	inches/mile	999	Save profile data - RoadRuf, Maximum IRI is 500 inches per mile
Transverse Cracking Severity 1	NT_CR1_LF	BIT/BOJ/BOC	Linear Feet	99999	A crack with the sealant in good condition such that the crack width cannot be determined, or A closed, unsealed crack.
Transverse Cracking Severity 2	NT_CR2_LF	BIT/BOJ/BOC	Linear Feet	99999	An open, unsealed crack, or Any crack (sealed or unsealed) with adjacent (within 1 foot) random cracking.
Longitudinal Cracking Severity 1	NL_CR1_LF	BIT/BOJ/BOC	Linear Feet	99999	A crack with the sealant in good condition such that the crack width cannot be estimated, or A closed, unsealed crack.
Longitudinal Cracking Severity 2	NL_CR2_LF	BIT/BOJ/BOC	Linear Feet	99999	An open, unsealed crack, or Any crack (sealed or unsealed) with adjacent random cracking.
Longitudinal Lane Joint Severity 1	NL_JT1_LF	BIT/BOJ/BOC	Linear Feet	99999	A longitudinal paving joint with the sealant in good condition such that the width cannot be estimated, or An open, unsealed joint.
Longitudinal Lane Joint Severity 2	NL_JT2_LF	BIT/BOJ/BOC	Linear Feet	99999	The longitudinal paving joint must be cracked with severe spalling or adjacent random cracking
Reflective Transverse Cracking Severity 1	NRT_CR1_LF	BOJ/BOC	Linear Feet	9999	A crack with the sealant in good condition such that the crack width cannot be determined, or A closed, unsealed crack.
Reflective Transverse Cracking Severity 2	NRT_CR2_LF	BOJ/BOC	Linear Feet	9999	A crack with width more than or equal to ¼ inches but less than ¾ inches; or A crack with width less than ¾ inches and with adjacent (within 1 foot) random cracking; and One level-1 or level-2 crack with an adjacent (within 1 foot) level-1 crack is rated as one crack of level 2.
Reflective Transverse Cracking Severity 3	NRT_CR3_LF	BOJ/BOC	Linear Feet	9999	A crack with width more than or equal to ¾ inches; or A crack with width more than ¾ inches and with deterioration for a width greater than 6 inches; and Two adjacent (within 1 foot) level-2 and/or level-3 cracks are rated as one crack of level 3.
Reflective Longitudinal Cracking Severity 1	NRL_CR1_LF	BOJ/BOC	Linear Feet	99999	A crack with the sealant in good condition such that the crack width cannot be determined, or A closed, unsealed crack.
Reflective Longitudinal Cracking Severity 2	NRL_CR2_LF	BOJ/BOC	Linear Feet	99999	A crack with width more than or equal to ¼ inches but less than ¾ inches; or A crack with width less than ¾ inches and with adjacent (within 1 foot) random cracking; and One level-1 or level-2 crack with an adjacent (within 1 foot) level-1 crack is rated as one crack of level 2.
Reflective Longitudinal Cracking Severity 3	NRL_CR3_LF	BOJ/BOC	Linear Feet	99999	A crack with width more than or equal to ¾ inches; or A crack with width more than ¾ inches and with deterioration for a width greater than 6 inches; and Two adjacent (within 1 foot) level-2 and/or level-3 cracks are rated as one crack of level 3.
Alligator Cracking Severity 1	NA_CR1_SF	BIT/BOJ/BOC	Square Feet	99999	A single sealed or unsealed longitudinal crack in the wheel path, or An area of cracks with no or few interconnecting cracks with no spalling.
Alligator Cracking Severity 2	NA_CR2_SF	BIT/BOJ/BOC	Square Feet	99999	An area of interconnecting cracks forming the characteristic alligator pattern; may have slight spalling.
Alligator Cracking Severity 3	NA_CR3_SF	BIT/BOJ/BOC	Square Feet	99999	An area of moderately or severely spalled cracks forming the characteristic alligator pattern.
Patching Area - wheel path	NPA_WWP_SF	BIT/BOJ/BOC	Square Feet	999999	Area - wheel path only - Max length of patch is 1320ft
Patching Area - Non wheel path	NPA_NWP_SF	BIT/BOJ/BOC	Square Feet	999999	Area - non wheel path only - Max length of patch is 1320ft
Potholes Count	NPOT_NO	BIT/BOJ/BOC	Count	999	
Delaminations Area	NDELAM_SF	BIT/BOJ/BOC	Square Feet	9999	
Bleeding Severity 1	NBLEED1_SF	BIT/BOJ/BOC	Square Feet	9999	Pavement surface that is discolored relative to the remainder of the surface due to excessive liquid asphalt.
Bleeding Severity 2	NBLEED2_SF	BIT/BOJ/BOC	Square Feet	9999	Excessive liquid asphalt gives the pavement surface a shiny appearance; tire marks may be evident in warm weather.
Average Deeper Rut (Straight-edge)	NRUT_S_AVG	BIT/BOJ/BOC	Inch	9.99	Reject greater than 3 inches
Notes:					
** Roughness Summary Values do not include low speed or bridge, construction and lane deviation values					
***Distress Summary Values do not include Construction, Lane Deviations or Bridge values.					

Table A2. Distress Data and Format for CRC Pavement

Description	Field Name	Pavement Type	Units	Format	Comments
IRI Left WP	NIRI_L	CRCP	inches/mile	999	Save profile data - RoadRuf, Maximum IRI is 500 inches per mile
IRI Right WP	NIRI_R	CRCP	inches/mile	999	Save profile data - RoadRuf, Maximum IRI is 500 inches per mile
IRI Average	NIRI_AVG	CRCP	inches/mile	999	Save profile data - RoadRuf, Maximum IRI is 500 inches per mile
Transverse Cracking Severity 1	NT_CR1	CRCP	Linear Feet	99999	A closed transverse crack with no spalling
Transverse Cracking Severity 2	NT_CR2	CRCP	Linear Feet	99999	An open transverse crack with no spalling
Transverse Cracking Severity 3	NT_CR3	CRCP	Linear Feet	99999	Any transverse crack with spalling
Transverse Cracking Total Number	NT_CR_NO	CRCP	Count	999	
Transverse Crack Average Spacing	NT_CR_AVG	CRCP	Linear Feet	999.9	(Tenth mile - length of Cluster cracking) / Number of Trans cracks
Longitudinal Cracking Severity 1	NL_CR1	CRCP	Linear Feet	9999	A longitudinal crack with no spalling
Longitudinal Cracking Severity 2	NL_CR2	CRCP	Linear Feet	9999	A longitudinal crack with less than or equal to ¼ of the crack length containing spalling
Longitudinal Cracking Severity 3	NL_CR3	CRCP	Linear Feet	9999	A longitudinal crack with greater than ¼ of the crack length containing spalling
Clustered Cracking Severity 1	NCL_CR1_NO	CRCP	Count	9999	Clusters of three or more transverse cracks having an average spacing greater than 1 foot and less than or equal to 2 feet
Clustered Cracking Severity 2	NCL_CR2_NO	CRCP	Count	9999	Clustered cracks with an average spacing of less than or equal to 1 foot
Clustered Cracking Severity 1	NCL_CR1_SF	CRCP	Square Feet	9999	Clusters of three or more transverse cracks having an average spacing greater than 1 foot and less than or equal to 2 feet
Clustered Cracking Severity 2	NCL_CR2_SF	CRCP	Square Feet	9999	Clustered cracks with an average spacing of less than or equal to 1 foot
Longitudinal Joint Spalling	NCL_J_SP_LF	CRCP	Linear Feet	9999	
Longitudinal Joint Fully (90%) Sealed	CCL_J_SEAL	CRCP	Yes/No	x	
Punchouts and Spalled Ycracks	NPUNCH_NO	CRCP	Count	99	Add number of "NPUNCH_SF" for count
Punchouts and Spalled Ycracks	NPUNCH_SF	CRCP	Square Feet	9999	
PCC Patch Severity 1	NC_PAT1_SF	CRCP	Square Feet	9999	The patch has no distress either in the patch or around its perimeter
PCC Patch Severity 2	NC_PAT2_SF	CRCP	Square Feet	9999	The patch has any type of severity level 1 CRCP distress either in the patch or around its perimeter
PCC Patch Severity 3	NC_PAT3_SF	CRCP	Square Feet	9999	The patch has any type of severity level 2 CRCP distress either in the patch or around its perimeter
Asphalt Patching	NA_PAT_SF	CRCP	Square Feet	9999	

Notes:

** Roughness Summary Values do not include low speed or bridge, construction and lane deviation values

***Distress Summary Values do not include Construction, Lane Deviations or Bridge values.

Table A3. Distress Data and Format for JRC Pavement

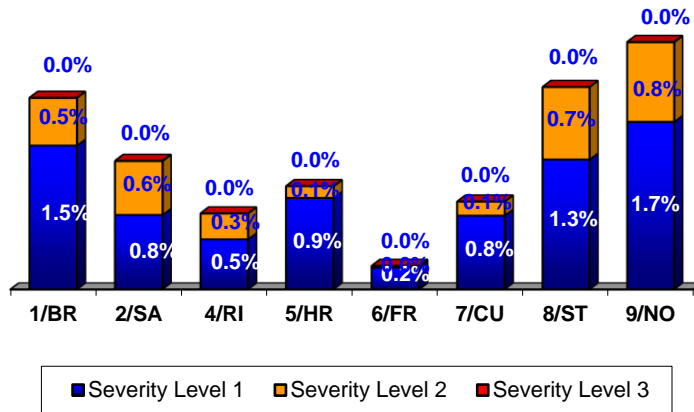
Description	Field Name	Pavement Type	Units	Format	Comments
IRI Left WP	NIRI_L	JRCP	inches/mile	999	Save profile data - RoadRuf, Maximum IRI is 500 inches per mile
IRI Right WP	NIRI_R	JRCP	inches/mile	999	Save profile data - RoadRuf, Maximum IRI is 500 inches per mile
IRI Average	NIRI_AVG	JRCP	inches/mile	999	Save profile data - RoadRuf, Maximum IRI is 500 inches per mile
Transverse Cracking Severity 1	NT_CR1_NS	JRCP	# of Slabs	9999	A crack that is well sealed so the width cannot be determined, or A closed crack that has no spalling.
Transverse Cracking Severity 2	NT_CR2_NS	JRCP	# of Slabs	9999	An open crack, or Any spalled crack.
Longitudinal Cracking Severity 1	NL_CR1_NS	JRCP	# of Slabs	9999	A crack that is well sealed so the width cannot be determined, or A closed crack that has no spalling.
Longitudinal Cracking Severity 2	NL_CR2_NS	JRCP	# of Slabs	9999	An open crack, or Any spalled crack.
PCC Patch Severity 1	NC_PAT1_NS	JRCP	# of Slabs	9999	The patch has no distress either in the patch or around its perimeter.
PCC Patch Severity 2	NC_PAT2_NS	JRCP	# of Slabs	9999	The patch has severity level 1, longitudinal cracking, transverse cracking (or any other severity level 1 distress) either in the patch or around its perimeter.
PCC Patch Severity 3	NC_PAT3_NS	JRCP	# of Slabs	9999	The patch has spalling, severity 2 longitudinal cracking or transverse cracking (or any other severity level 2 distress) either in the patch or around its perimeter.
Asphalt Patch	NA_PAT_NS	JRCP	# of Slabs	9999	
Number of Transverse Joints	NNO_T_JTS	JRCP	Count	999	
Average Slab Length	NSLAB_AVG	JRCP	Feet	999	(# of Joints -1) / Output summary length = Average Slab Length
Transverse Joint Spalled	NT_J_SP_NS	JRCP	# of Slabs	9999	
Transverse Joint Fully Sealed	NT_J_FS_NS	JRCP	# of Joints	9999	
Longitudinal Joint Spalled	NL_J_SP_NS	JRCP	# of Slabs	9999	
Longitudinal Joint Fully Sealed	NL_J_FS_NS	JRCP	# of Slabs	9999	
Corner Breaks Severity 1	NC_BRK1_NS	JRCP	# of Slabs	9999	The crack is spalled for no more than 1/4th of its length and the corner break is in one piece.
Corner Breaks Severity 2	NC_BRK2_NS	JRCP	# of Slabs	9999	The crack is spalled for more than 1/4th of its length, or The corner break is in two or more pieces.
Divided Slabs	NDIV_NS	JRCP	# of Slabs	9999	
Blowups	NBLOW_NS	JRCP	# of Slabs	9999	
Joint Fault Severity 1	NJFL_T1_PER	JRCP	Percent	999.9	0 - .49
Joint Fault Severity 2	NJFL_T2_PER	JRCP	Percent	999.9	.49 - 1.0
Joint Fault Severity 3	NJFL_T3_PER	JRCP	Percent	999.9	>1
Average Joint Fault in Left Wheel Path	NJFLT_LT_AVG	JRCP	Inch	9.99	
Average Joint Fault in Right Wheel Path	NJFLT_RT_AVG	JRCP	Inch	9.99	
Joint Fault None (<0.8")	NJFLT0_PER	JRCP	Percent	999.9	No faulting
Notes:					
** Roughness Summary Values do not include low speed or bridge, construction and lane deviation values					
***Distress Summary Values do not include Construction, Lane Deviations or Bridge values.					

Table A4. Distress Data in ACPINPUT Table for Asphalt Concrete Pavement

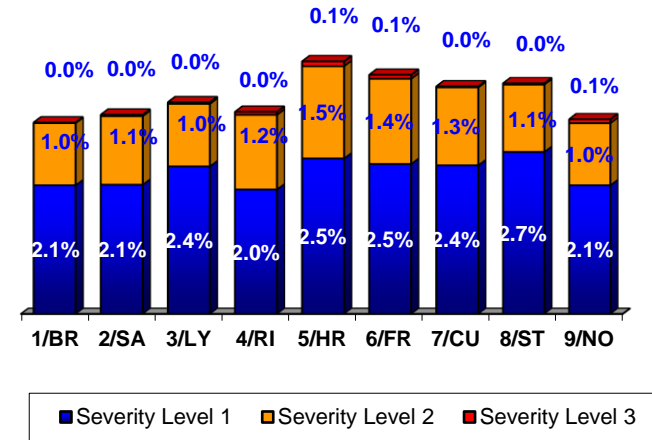
Description	Field Name	Format	Comments	Calculations
Frequency of Alligator/Fatigue cracking. This is a numeric field with values of 0, 1, 2 or 3.	la_cr_freq	9	0 is none, 1 is rare, 2 is occasional and 3 is frequent.	rare = (wheel path + non wheel path alligator cracking area in SF) / (7*length), if this quantity is > 0 to 10% : Occasional is >10% and <=50%; : frequent is >50%. Here length is (end_mp - begin_mp). The codes are 0, 1, 2 and 3.
Severity of Alligator/Fatigue cracking. This is a numeric field with values of 0, 1, or 2.	la_cr_severity	9	0 is not severe (severity 1), 1 is severe (severity 2) and 2 is very severe (severity 3).	severity of the most prevalent type; i.e. if 10% of the cracks are not severe (severity 1), 15% severe (severity 2) and 2% very severe (severity 3) then severity for the entire section is "severe".
Total number of transverse cracks in the sections. This is a numeric field with the format 999999.	tr_cr_freq	9999999	Actual Count of Cracks in Section	Total (of all severities)Linear feet /12. This includes transverse cracks, and reflective transverse cracks.
Severity of majority of the transverse cracks in the sections. This is a numeric field with values of 0, 1, or 2.	tr_cr_severity	9	If the Pavement Type is 'BIT', transverse cracks will have two severity levels; 0 for Not Severe (severity 1) and 1 for Severe (severity 2). If the pavement type is BOJ or BOC then it will have three severity levels; 0 for Not Severe (severity 1) and 1 for Severe (severity 2) and 2 for very severe (severity 3).	severity of the most prevalent type; i.e. if 1000 LF of the cracks are not severe (severity 1), 1200 LF of cracks severe (severity 2) then severity for the entire section is "severe" (severity 2).
Frequency of Rutting in the section. This is a numeric field with values of 0, 1, or 2.	rutting_freq	9	0 is None, 1 is 'Rare' and 2 is 'Widespread'	None: If all the values from the 0.1 mile table are <0.1" rutting value for the homogeneous section. Rare: if <=10% of the readings in the sections affected, i.e., from 0.1 mile tables if <=10% of the readings(records) have a rutting value of >=0.1 and <0.5". Widespread: more than 10% of the readings affected, i.e., from 0.1 mile tables if >10% of the readings(records) have a rutting value of >=0.1 and <0.5". In case there are >0.5" rutting values, it is rare if <=10% are >0.5"; and widespread if >10% are >0.5".
Severity of rutting in the section. This is a numeric field with values of 0 or 1.	rutting_severity	9	0 is for less than half inch average for section, and 1 is for more than half inch average for section	if the average reading for the section is >= 0.1" to 0.5" then 0; if the average for the section is >0.5" then 1
Frequency of Patching in the section. This is a numeric field with values of 0 or 1.	patches_freq	9	0 is none or no patches in the section, 1 is for yes or there are patches in the section	This includes patches in both wheel path and non-wheel path.
Severity of Patching in the section. This is a numeric field with values of 0 or 1.	patches_severity	9	0 is for less than 10% of the pavement area is patched, 1 is for more than 10% of the pavement area is patched. This includes patches in both wheel paths and non wheel paths.	The area of pavement is determined by length * 12. Here a width of 12' is considered irrespective of the widths determined by other means. Here length is (end_mp - begin_mp).
Acceptable' or 'Unacceptable' based on the quality of the ride	ride_quality	9	0 is acceptable; 1 is unacceptable where IRI>140 in/mi.	if the average of left and right IRI for the whole section is >200 then -1, otherwise 0
Notes:				
** Roughness Summary Values do not include low speed or bridge, construction and lane deviation values				
***Distress Summary Values do not include Construction, Lane Deviations or Bridge values.				

**APPENDIX B: DISTRIBUTION OF KEY DISTRESSES
BY DISTRICTS AND SYSTEMS**

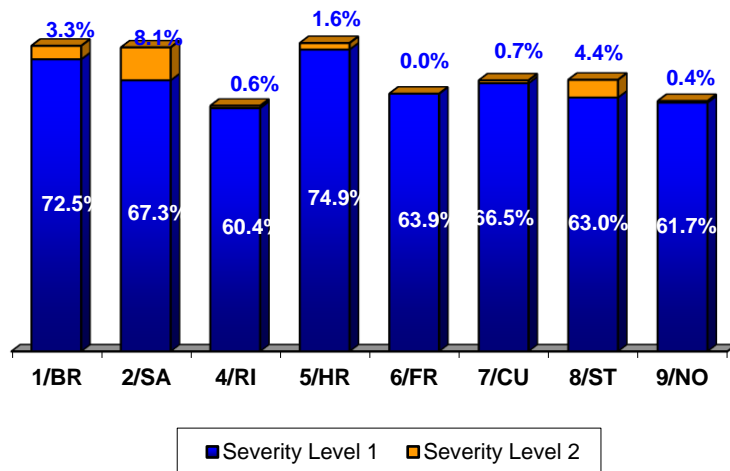
Interstate Asphalt Pavement - Alligator Cracking
(% of total area)



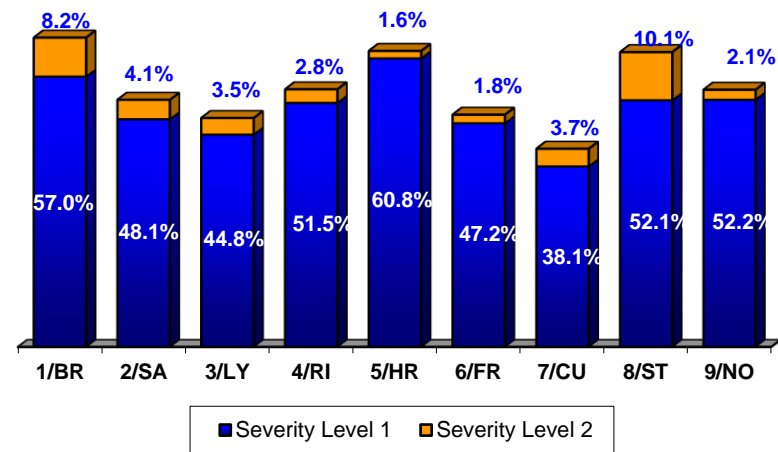
Primary Asphalt Pavement - Alligator Cracking
(% of total area)

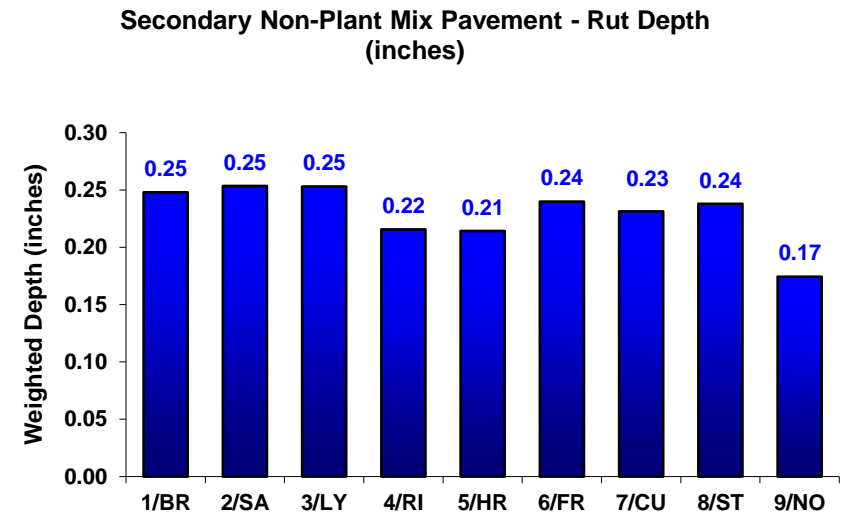
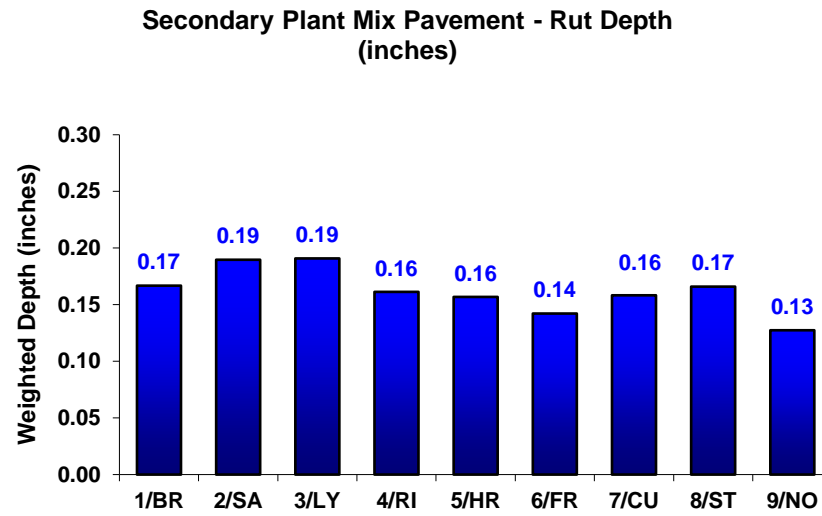
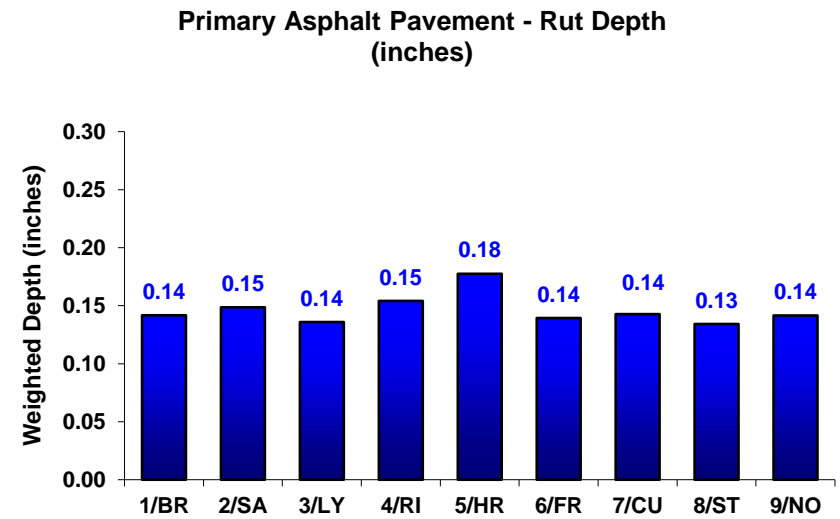
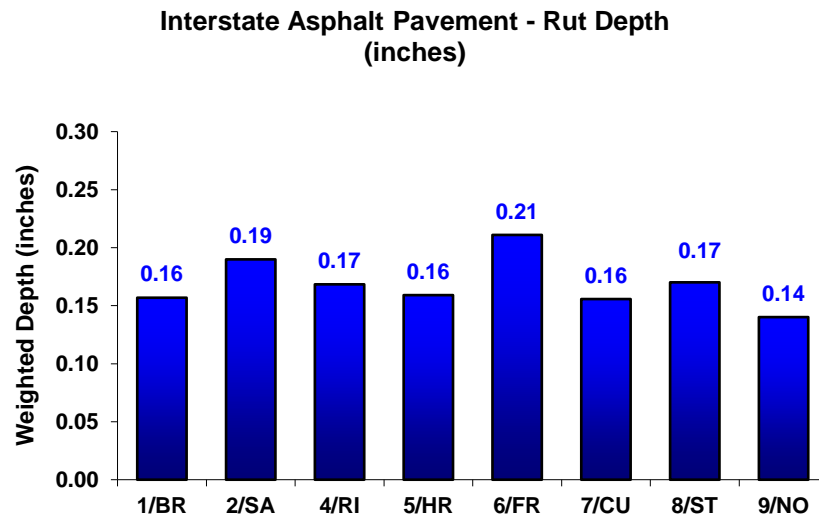


Interstate Asphalt Pavement - Patching
(% of pavement with patching, weighted by area)

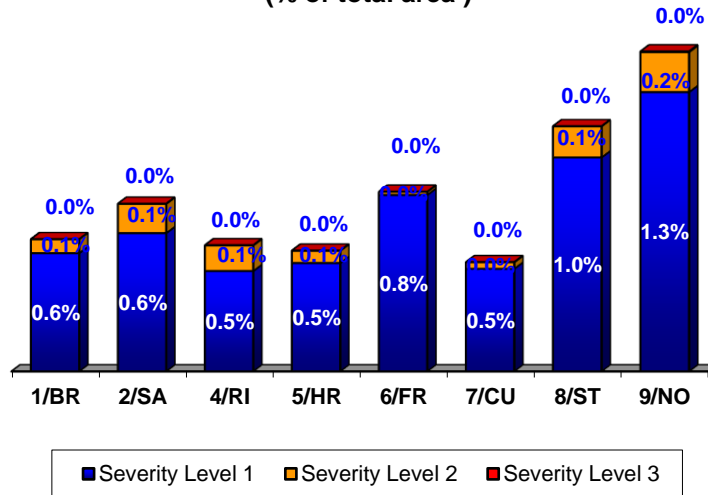


Primary Asphalt Pavement - Patching
(% of pavement with patching, weighted by area)

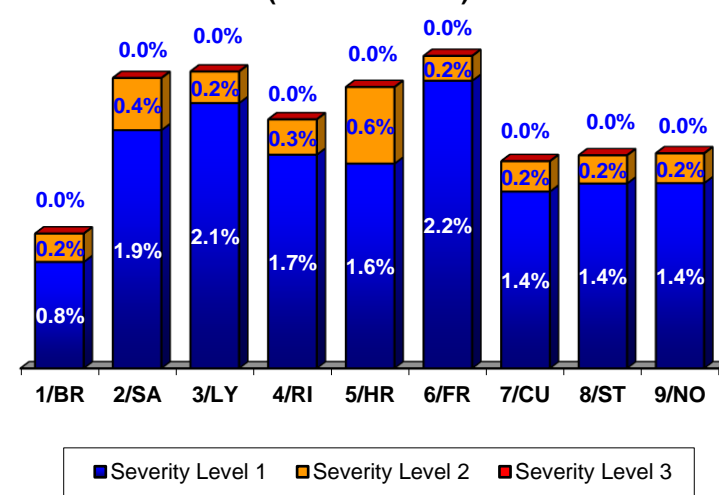




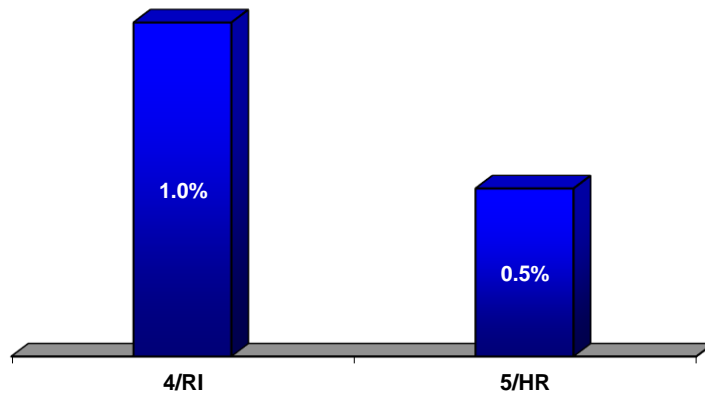
Interstate Asphalt Pavement - Transverse Cracking
(% of total area)



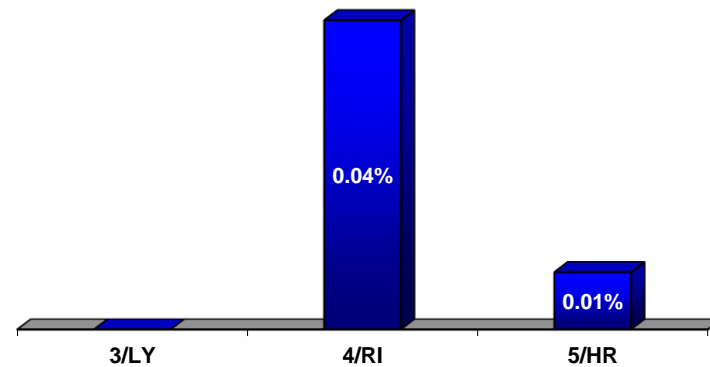
Primary Asphalt Pavement - Transverse Cracking
(% of total area)



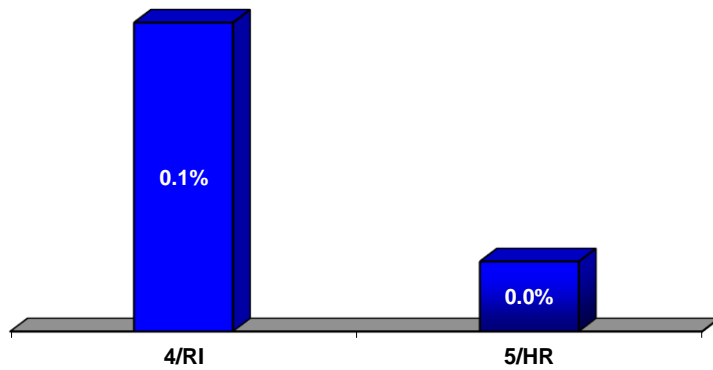
Interstate CRC Pavement - Asphalt Patching
(% of total area)



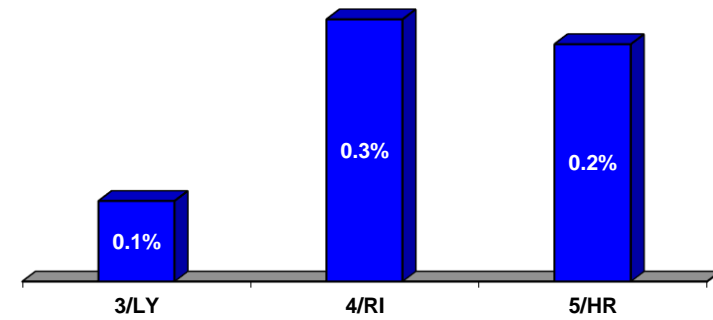
Primary CRC Pavement - Asphalt Patching
(% of total area)



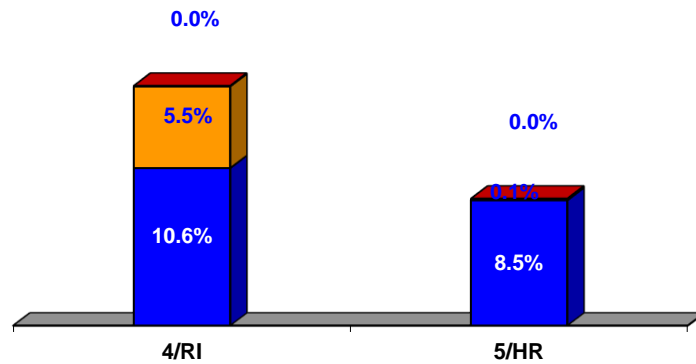
**Interstate CRC Pavement - Punchout
(% of total area)**



**Primary CRC Pavement - Punchout
(% of total area)**

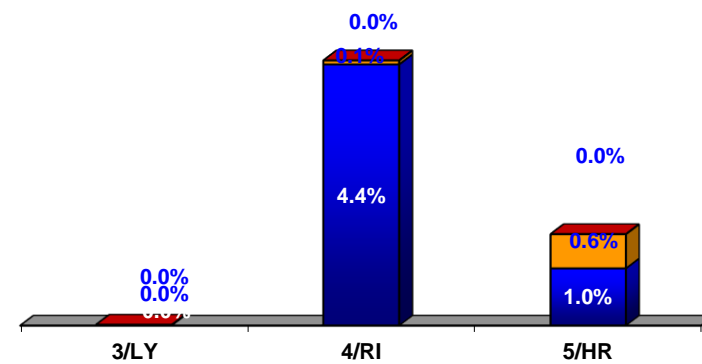


**Interstate CRC Pavement - PCC Patching
(% of total area)**



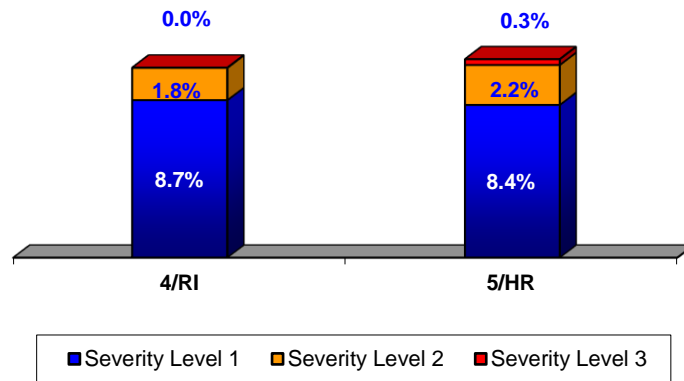
■ Severity Level 1 ■ Severity Level 2 ■ Severity Level 3

**Primary CRC Pavement - PCC Patching
(% of total area)**

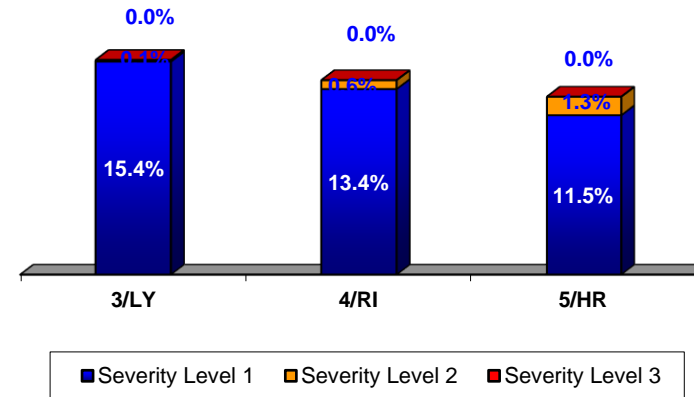


■ Severity Level 1 ■ Severity Level 2 ■ Severity Level 3

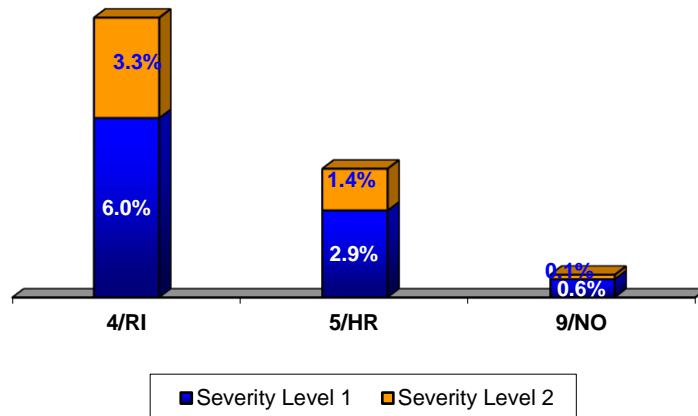
Interstate CRC Pavement-Transverse Cracking
(% of total area)



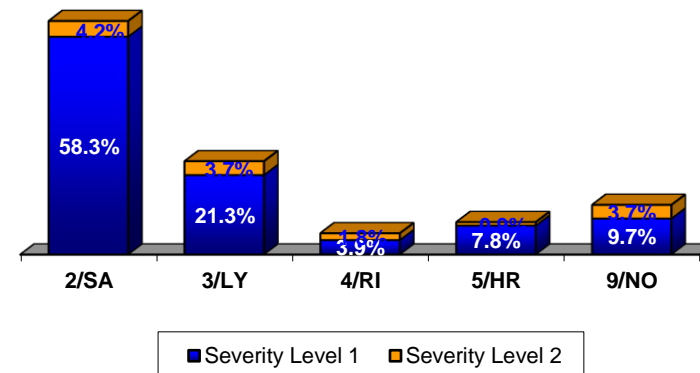
Primary CRC Pavement - Transverse Cracking
(% of total area)



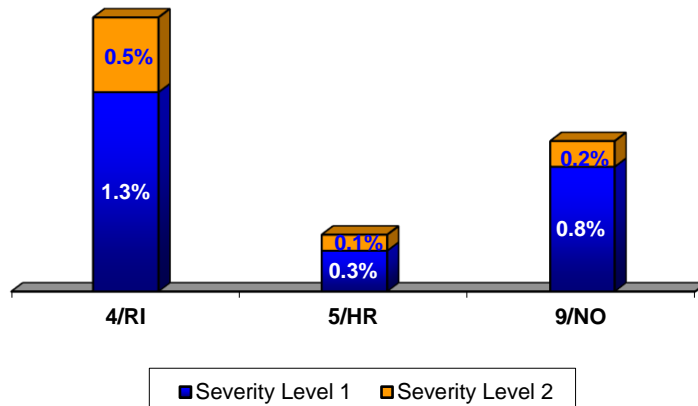
Interstate JRC Pavement - Transverse Cracking
(% of total slabs)



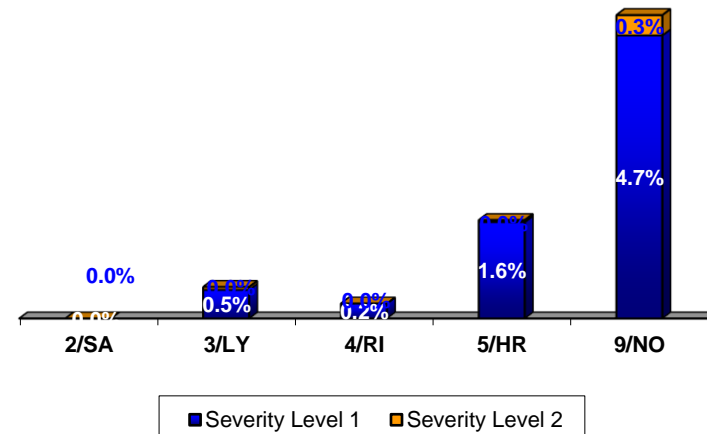
Primary JRC Pavement - Transverse Cracking
(% of total slabs)



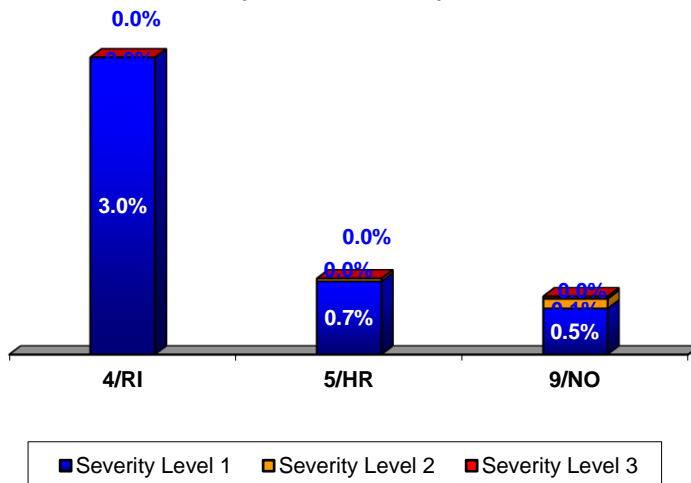
**Interstate JRC Pavement - Corner Breaks
(% of total slabs)**



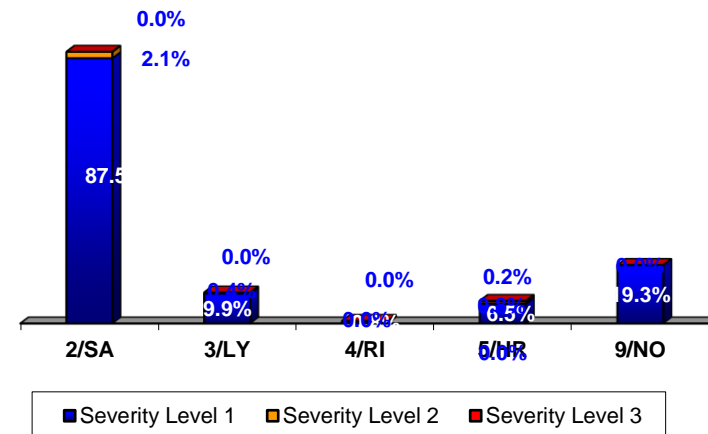
**Primary JRC Pavement - Corner Breaks
(% of total slabs)**



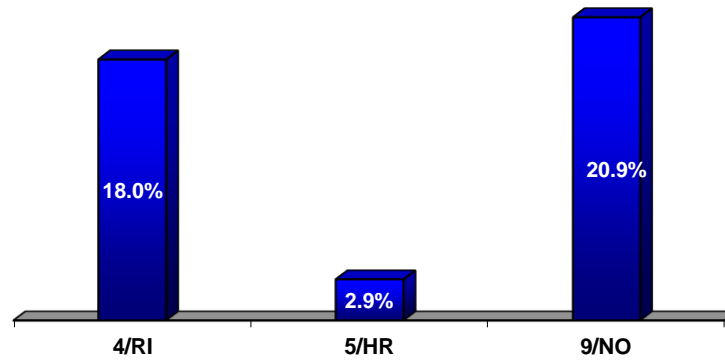
**Interstate JRC Pavement - PCC Patching
(% of total slabs)**



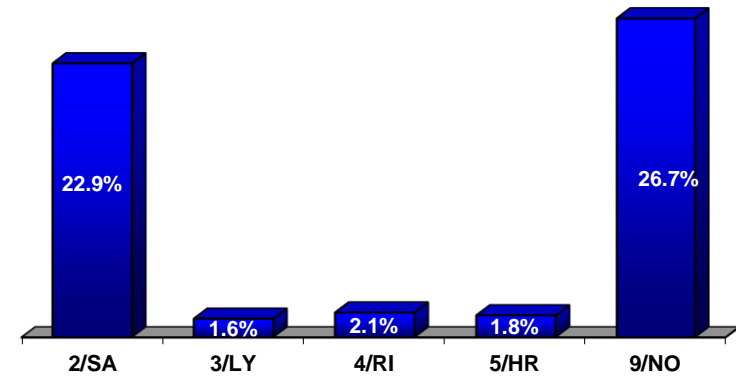
**Primary JRC Pavement - PCC Patching
(% of total slabs)**



**Interstate JRC Pavement - Asphalt Patching
(% of total slabs)**



**Primary JRC Pavement - Asphalt Patching
(% of total slabs)**



**APPENDIX C: PAVEMENT CONDITION BY DISTRICT AND COUNTY -
2018**

Table C1. Pavement Condition by District and County for Interstate System – 2018

District	County No.	County Name	Lane Miles Rated, Interstate	Deficient Lane Miles	% Deficient
Bristol (1)	10	Bland	86.76	5.58	6.43%
	86	Smythe	93.18	1.38	1.48%
	95	Washington	164.62	9.30	5.65%
	98	Wythe	192.18	15.16	7.89%
District 1 Total			536.74	31.42	5.85%
Salem (2)	11	Botetourt	107.20	0.00	0.00%
	17	Carroll	103.69	12.72	12.27%
	60	Montgomery	109.75	18.40	16.77%
	77	Pulaski	70.31	15.78	22.45%
	80	Roanoke	106.99	17.11	15.99%
District 2 Total			497.94	64.01	12.85%
Richmond (4)	12	Brunswick	82.14	10.08	12.27%
	20	Chesterfield	136.80	5.55	4.06%
	26	Dinwiddie	121.02	1.30	1.07%
	37	Goochland	111.66	7.93	7.10%
	42	Hanover	167.74	13.35	7.96%
	43	Henrico	398.88	33.33	8.36%
	58	Mecklenburg	76.62	15.78	20.60%
	63	New Kent	80.48	1.86	2.31%
	74	Prince George	132.15	31.66	23.96%
District 4 Total			1307.49	120.84	9.24%
Hampton Roads (5)	40	Greensville	68.56	0.00	0.00%
	47	James City	34.76	0.00	0.00%
	61	Nansemond	13.60	0.00	0.00%
	64	Norfolk	307.34	2.74	0.89%
	75	Princess Anne	91.37	0.00	0.00%
	91	Sussex	70.34	4.84	6.88%
	99	York	228.21	8.58	3.76%
District 5 Total			814.18	16.16	1.98%
Fredericksburg (6)	16	Caroline	93.69	0.00	0.00%
	88	Spotsylvania	92.55	2.04	2.20%
	89	Stafford	91.77	0.00	0.00%
District 6 Total			278.01	2.04	0.73%
Culpeper (7)	2	Albemarle	124.82	6.86	5.50%
	30	Fauquier	87.80	1.96	2.23%
	54	Louisa	66.62	0.00	0.00%
District 7 Total			279.24	8.82	3.16%
Staunton (8)	3	Alleghany	163.79	21.38	13.05%
	7	Augusta	191.91	38.50	20.06%
	34	Frederick	102.22	14.80	14.48%
	81	Rockbridge	210.11	33.78	16.08%

District	County No.	County Name	Lane Miles Rated, Interstate	Deficient Lane Miles	% Deficient
Staunton (8)	82	Rockingham	108.36	17.72	16.35%
	85	Shenandoah	138.72	25.51	18.40%
	93	Warren	58.98	0.00	0.00%
District 8 Total			974.09	151.69	15.57%
Northern Virginia (9)	0	Arlington	65.86	13.50	20.50%
	29	Fairfax	437.89	61.74	14.10%
	76	Prince William	158.80	19.24	12.12%
District 9 Total			662.55	94.49	14.26%
Statewide			5350.24	489.46	9.15%

Table C2. Pavement Condition by District and County for Primary System – 2018

District	County No.	County Name	Lane Miles Rated, Primary	Deficient Lane Miles	% Deficient
Bristol (1)	10	Bland	155.07	41.50	26.76%
	13	Buchanan	182.08	10.89	5.98%
	25	Dickenson	163.14	32.52	19.93%
	38	Grayson	239.01	15.33	6.41%
	52	Lee	329.40	89.55	27.18%
	83	Russell	292.30	19.95	6.83%
	84	Scott	277.59	49.65	17.89%
	86	Smythe	170.17	14.57	8.56%
	92	Tazewell	351.82	24.32	6.91%
	95	Washington	243.65	55.05	22.59%
	97	Wise	344.06	98.26	28.56%
	98	Wythe	137.29	37.98	27.66%
District 1 Total			2885.58	489.57	16.97%
Salem (2)	9	Bedford	377.80	44.20	11.70%
	11	Botetourt	254.25	56.33	22.15%
	17	Carroll	202.96	60.13	29.62%
	22	Craig	119.42	13.14	11.01%
	31	Floyd	109.60	13.16	12.01%
	33	Franklin	241.94	22.05	9.11%
	35	Giles	231.37	48.50	20.96%
	44	Henry	344.24	48.96	14.22%
	60	Montgomery	196.22	62.11	31.65%
	70	Patrick	227.78	18.43	8.09%
	77	Pulaski	101.43	26.30	25.93%
	80	Roanoke	213.31	37.86	17.75%
District 2 Total			2620.32	451.17	17.22%
Lynchburg (3)	5	Amherst	286.17	18.86	6.59%
	6	Appomattox	149.31	9.21	6.17%
	14	Buckingham	194.78	24.42	12.54%
	15	Campbell	304.28	41.06	13.50%
	19	Charlotte	264.54	37.06	14.01%
	24	Cumberland	99.00	14.03	14.17%
	41	Halifax	412.20	69.13	16.77%
	62	Nelson	249.09	15.94	6.40%
	71	Pittsylvania	504.91	99.60	19.73%
	73	Prince Edward	182.11	36.42	20.00%
District 3 Total			2646.39	365.73	13.82%
Richmond (4)	4	Amelia	114.63	29.71	25.91%
	12	Brunswick	249.22	69.69	27.96%
	18	Charles City	88.90	6.79	7.64%
	20	Chesterfield	536.58	66.58	12.41%

District	County No.	County Name	Lane Miles Rated, Primary	Deficient Lane Miles	% Deficient
Richmond (4)	26	Dinwiddie	252.10	44.95	17.83%
	37	Goochland	190.53	19.49	10.23%
	42	Hanover	232.52	36.67	15.77%
	43	Henrico	350.46	56.38	16.09%
	55	Lunenburg	124.83	22.22	17.80%
	58	Mecklenburg	422.61	25.50	6.03%
	63	New Kent	185.22	20.97	11.32%
	67	Nottoway	207.05	33.95	16.40%
	72	Powhatan	125.27	25.35	20.23%
	74	Prince George	188.68	18.79	9.96%
District 4 Total			3268.60	477.04	14.59%
Hampton Roads (5)	1	Accomack	277.77	28.00	10.08%
	40	Greensville	81.32	27.97	34.42%
	46	Isle of Wight	198.77	21.47	10.80%
	47	James City	176.18	28.38	16.11%
	61	Nansemond	2.80	0.00	0.00%
	64	Norfolk	20.73	3.12	15.05%
	65	Northampton	143.56	26.35	18.35%
	87	Southampton	271.68	16.87	6.21%
	90	Surry	97.34	20.58	21.14%
	91	Sussex	220.58	16.80	7.62%
	99	York	143.99	3.11	2.16%
District 5 Total			1634.72	192.65	11.78%
Fredericksburg (6)	16	Caroline	284.86	18.89	6.63%
	28	Essex	172.96	26.09	15.09%
	36	Gloucester	185.87	24.37	13.11%
	48	King George	207.97	36.90	17.74%
	49	King & Queen	135.70	34.84	25.67%
	50	King William	109.93	17.43	15.86%
	51	Lancaster	126.63	24.83	19.61%
	57	Mathews	66.62	9.64	14.47%
	59	Middlesex	132.57	37.03	27.93%
	66	Northumberland	111.46	23.69	21.25%
	79	Richmond	107.60	3.40	3.16%
	88	Spotsylvania	212.06	30.28	14.28%
	89	Stafford	167.83	6.18	3.68%
	96	Westmoreland	141.16	22.98	16.28%
District 6 Total			2167.07	316.55	14.61%
Culpeper (7)	2	Albemarle	2167.07	316.55	14.61%
	23	Culpeper	355.93	69.83	19.62%
	30	Fauquier	211.08	24.20	11.47%
	32	Fluvanna	321.02	21.03	6.55%
	39	Greene	102.57	17.31	16.88%
	54	Louisa	87.64	28.41	32.41%

District	County No.	County Name	Lane Miles Rated, Primary	Deficient Lane Miles	% Deficient
Culpeper (7)	56	Madison	158.57	18.96	11.95%
	68	Orange	189.15	52.77	27.90%
	78	Rappahannock	160.41	17.98	11.21%
	District 7 Total		1829.06	281.79	15.41%
Staunton (8)	3	Alleghany	156.93	26.49	16.87%
	7	Augusta	425.26	52.80	12.42%
	8	Bath	149.37	42.32	28.33%
	21	Clarke	138.54	12.72	9.18%
	34	Frederick	343.32	1.86	0.54%
	45	Highland	142.08	39.16	27.56%
	69	Page	146.69	43.10	29.39%
	81	Rockbridge	269.56	89.93	33.36%
	82	Rockingham	404.79	115.42	28.51%
	85	Shenandoah	210.84	16.48	7.82%
	93	Warren	89.83	0.80	0.89%
District 8 Total			2477.21	441.08	17.81%
Northern Virginia (9)	0	Arlington	153.58	21.77	14.18%
	29	Fairfax	748.23	99.53	13.30%
	53	Loudoun	371.07	54.49	14.68%
	76	Prince William	380.44	27.15	7.14%
District 9 Total			1653.32	202.94	12.27%
Statewide			21182.27	3218.52	15.19%

**Table C3. Pavement Condition by District and County for
Secondary System – 2018**

District	County No.	County Name	Lane Miles Rated, Secondary	Deficient Lane Miles	% Deficient
Bristol (1)	10	Bland	337.56	159.97	47.39%
	13	Buchanan	855.19	359.83	42.08%
	25	Dickenson	790.50	342.57	43.34%
	38	Grayson	713.28	389.97	54.67%
	52	Lee	854.87	209.02	24.45%
	83	Russell	985.11	540.12	54.83%
	84	Scott	837.43	309.54	36.96%
	86	Smythe	783.53	382.91	48.87%
	92	Tazewell	795.83	258.87	32.53%
	95	Washington	1,297.01	749.38	57.78%
	97	Wise	774.40	263.97	34.09%
	98	Wythe	626.64	332.39	53.04%
District 1 Total			9651.35	4298.54	44.54%
Salem (2)	9	Bedford	1,548.76	421.60	27.22%
	11	Botetourt	821.67	329.57	40.11%
	17	Carroll	1,169.77	646.90	55.30%
	22	Craig	289.97	80.22	27.66%
	31	Floyd	640.42	327.37	51.12%
	33	Franklin	1,961.66	752.03	38.34%
	35	Giles	465.00	133.16	28.64%
	44	Henry	1,370.68	604.51	44.10%
	60	Montgomery	732.77	255.68	34.89%
	70	Patrick	1,047.87	374.08	35.70%
	77	Pulaski	641.99	238.55	37.16%
	80	Roanoke	1,135.42	541.62	47.70%
District 2 Total			11825.98	4705.29	39.79%
Lynchburg (3)	5	Amherst	863.95	452.50	52.38%
	6	Appomattox	788.74	231.96	29.41%
	14	Buckingham	849.84	313.69	36.91%
	15	Campbell	1,352.85	314.15	23.22%
	19	Charlotte	823.62	203.35	24.69%
	24	Cumberland	430.08	189.20	43.99%
	41	Halifax	1,582.47	338.85	21.41%
	62	Nelson	596.16	299.15	50.18%
	71	Pittsylvania	2,479.17	606.38	24.46%
	73	Prince Edward	657.63	161.31	24.53%
District 3 Total			10424.51	3110.54	29.84%
Richmond (4)	4	Amelia	658.38	269.12	40.88%
	12	Brunswick	1,019.88	331.98	32.55%
	18	Charles City	266.09	72.60	27.28%
	20	Chesterfield	3,486.17	1,779.40	51.04%

District	County No.	County Name	Lane Miles Rated, Secondary	Deficient Lane Miles	% Deficient
Richmond (4)	26	Dinwiddie	1,014.30	317.00	31.25%
	37	Goochland	664.91	314.09	47.24%
	42	Hanover	1,696.08	725.95	42.80%
	55	Lunenburg	695.63	247.56	35.59%
	58	Mecklenburg	1,167.12	261.85	22.44%
	63	New Kent	424.27	164.93	38.87%
	67	Nottoway	549.21	224.41	40.86%
	72	Powhatan	628.96	347.76	55.29%
	74	Prince George	595.32	199.97	33.59%
District 4 Total			12866.32	5256.62	40.86%
Hampton Roads (5)	1	Accomack	1,097.28	493.99	45.02%
	40	Greensville	548.04	57.08	10.42%
	46	Isle of Wight	830.97	153.42	18.46%
	47	James City	651.34	151.07	23.19%
	61	Nansemond	0.14	0.00	0.00%
	65	Northampton	485.21	181.18	37.34%
	87	Southampton	1,192.65	142.10	11.91%
	90	Surry	493.79	66.46	13.46%
	91	Sussex	805.94	87.82	10.90%
	99	York	611.30	175.80	28.76%
District 5 Total			6716.66	1508.92	22.47%
Fredericksburg (6)	16	Caroline	902.64	294.95	32.68%
	28	Essex	483.31	280.29	57.99%
	36	Gloucester	608.76	288.78	47.44%
	48	King George	338.34	104.88	31.00%
	49	King & Queen	458.87	160.23	34.92%
	50	King William	499.05	171.13	34.29%
	51	Lancaster	419.92	145.04	34.54%
	57	Mathews	267.78	115.38	43.09%
	59	Middlesex	335.25	63.68	18.99%
	66	Northumberland	662.17	413.69	62.47%
	79	Richmond	404.81	189.00	46.69%
	88	Spotsylvania	1,468.44	582.57	39.67%
	89	Stafford	1,280.77	562.69	43.93%
	96	Westmoreland	600.22	357.12	59.50%
District 6 Total			8730.33	3729.43	42.72%
Culpeper (7)	2	Albemarle	1,408.53	507.69	36.04%
	23	Culpeper	734.83	365.77	49.78%
	30	Fauquier	1,301.19	803.89	61.78%
	32	Fluvanna	573.83	55.30	9.64%
	39	Greene	299.57	113.71	37.96%
	54	Louisa	1,035.08	290.13	28.03%
	56	Madison	431.95	171.80	39.77%
	68	Orange	581.68	248.31	42.69%

District	County No.	County Name	Lane Miles Rated, Secondary (Samples)	Deficient Lane Miles	% Deficient
	78	Rappahannock	270.27	135.93	50.29%
District 7 Total			6636.93	2692.53	40.57%
Staunton (8)	3	Alleghany	438.23	160.49	36.62%
	7	Augusta	1,578.96	550.61	34.87%
	8	Bath	524.40	222.83	42.49%
	21	Clarke	337.33	71.94	21.33%
	34	Frederick	1,042.83	241.10	23.12%
	45	Highland	229.35	97.60	42.56%
	69	Page	503.88	56.24	11.16%
	81	Rockbridge	899.34	420.39	46.74%
	82	Rockingham	1,320.05	361.73	27.40%
	85	Shenandoah	865.02	250.45	28.95%
	93	Warren	324.76	64.85	19.97%
District 8 Total			8064.15	2498.23	30.98%
Northern Virginia (9)	29	Fairfax	5,546.34	3,387.88	61.08%
	53	Loudoun	2,129.53	1,149.18	53.96%
	76	Prince William	2,283.95	1,348.38	59.04%
District 9 Total			9959.82	5885.44	59.09%
Statewide			84,876.05	33,685.54	39.69%

**APPENDIX D: PAVEMENT CONDITION MAPS FOR INTERSTATE AND
PRIMARY SYSTEMS - 2018**

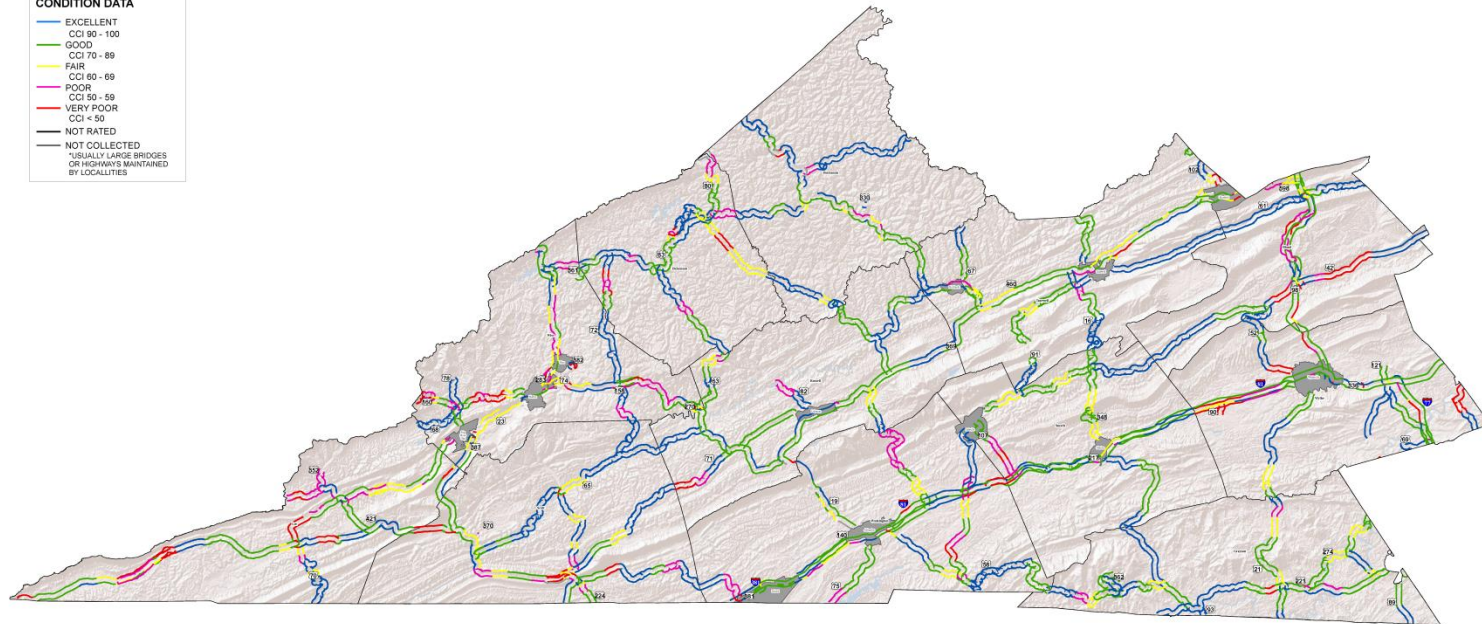


Bristol District

VIRGINIA DEPARTMENT OF TRANSPORTATION
PAVEMENT CONDITIONS 2018
INTERSTATE AND PRIMARY ROUTES



CONDITION DATA	
EXCELLENT	CCI 80 - 100
GOOD	CCI 70 - 89
FAIR	CCI 60 - 69
POOR	CCI 50 - 59
VERY POOR	CCI < 50
NOT RATED	
NOT COLLECTED	USUALLY LARGE BRIDGES OR HIGHWAYS MAINTAINED BY LOCALITIES



0 12.5 25 50 Miles

VDOT Virginia Department of Transportation
Maintenance

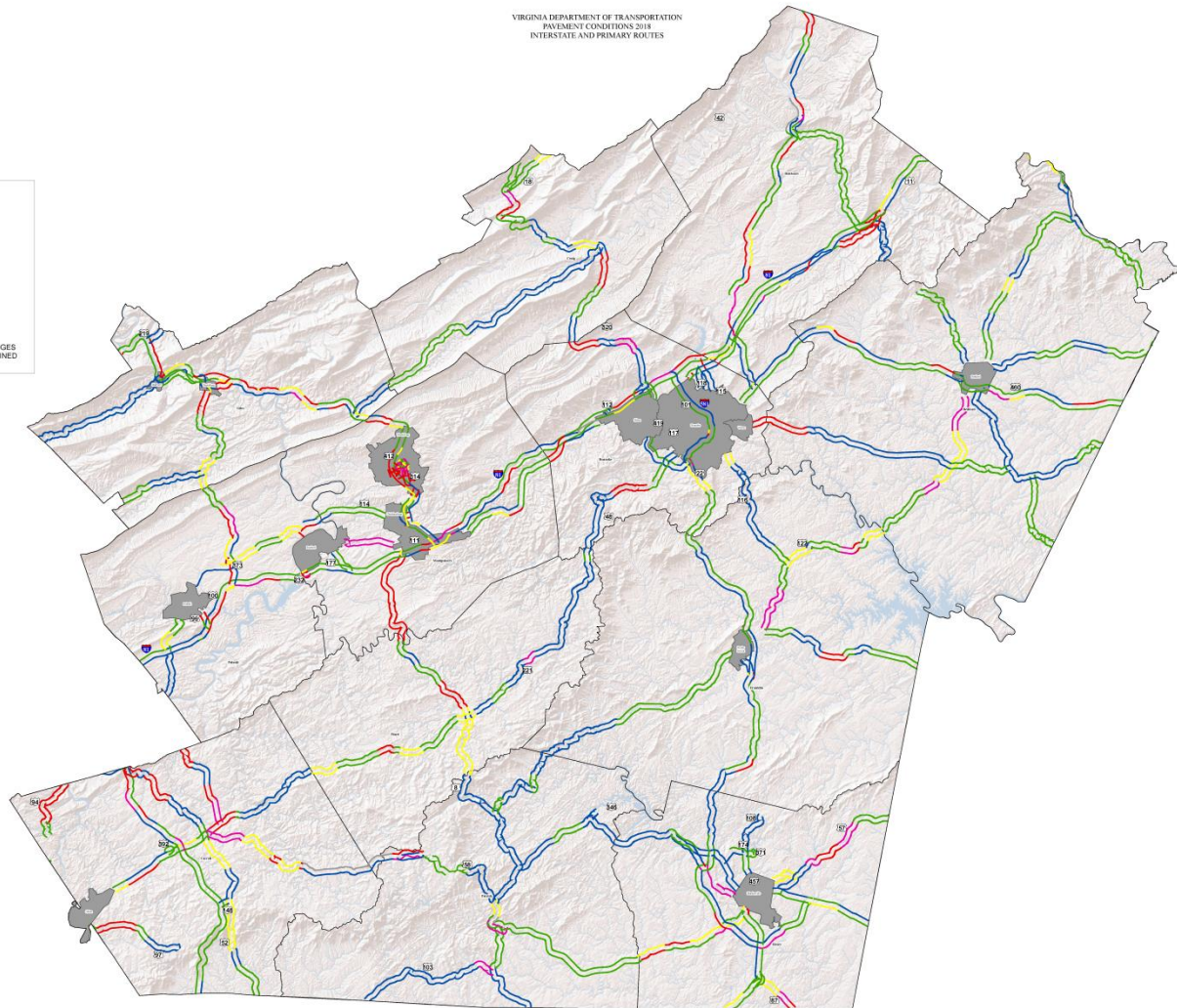


Salem District

VIRGINIA DEPARTMENT OF TRANSPORTATION
PAVEMENT CONDITIONS 2018
INTERSTATE AND PRIMARY ROUTES



CONDITION DATA	
EXCELLENT	CCI 90 - 100
GOOD	CCI 70 - 89
FAIR	CCI 60 - 69
POOR	CCI 50 - 59
VERY POOR	CCI < 50
NOT RATED	
NOT COLLECTED	
*USUALLY LARGE BRIDGES OR HIGHWAYS MAINTAINED BY LOCALITIES	



0 10 20 40 Miles

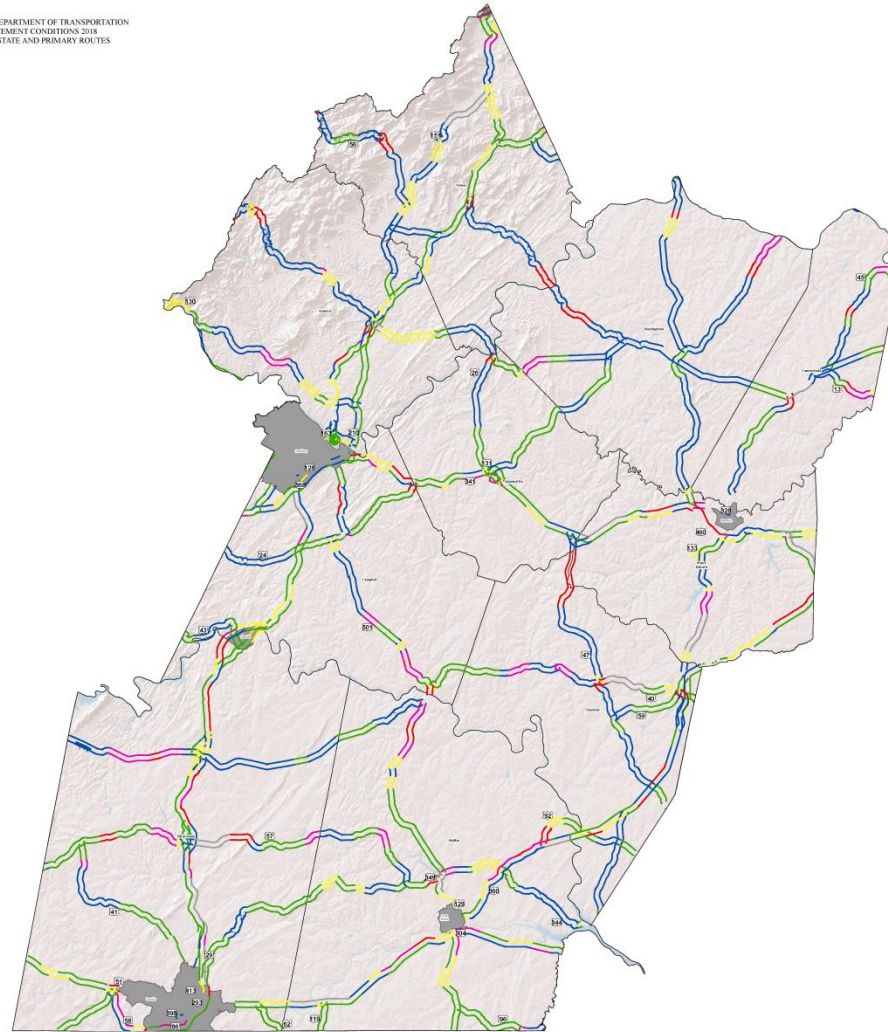


Lynchburg District

VIRGINIA DEPARTMENT OF TRANSPORTATION
PAVEMENT CONDITIONS 2018
INTERSTATE AND PRIMARY ROUTES



CONDITION DATA	
EXCELLENT	CCI 90 - 100
GOOD	CCI 70 - 89
FAIR	CCI 60 - 69
POOR	CCI 50 - 59
VERY POOR	CCI < 50
NOT RATED	
NOT COLLECTED	
*USUALLY LARGE BRIDGES OR HIGHWAYS MAINTAINED BY LOCALITIES	



0 10 20 40 Miles

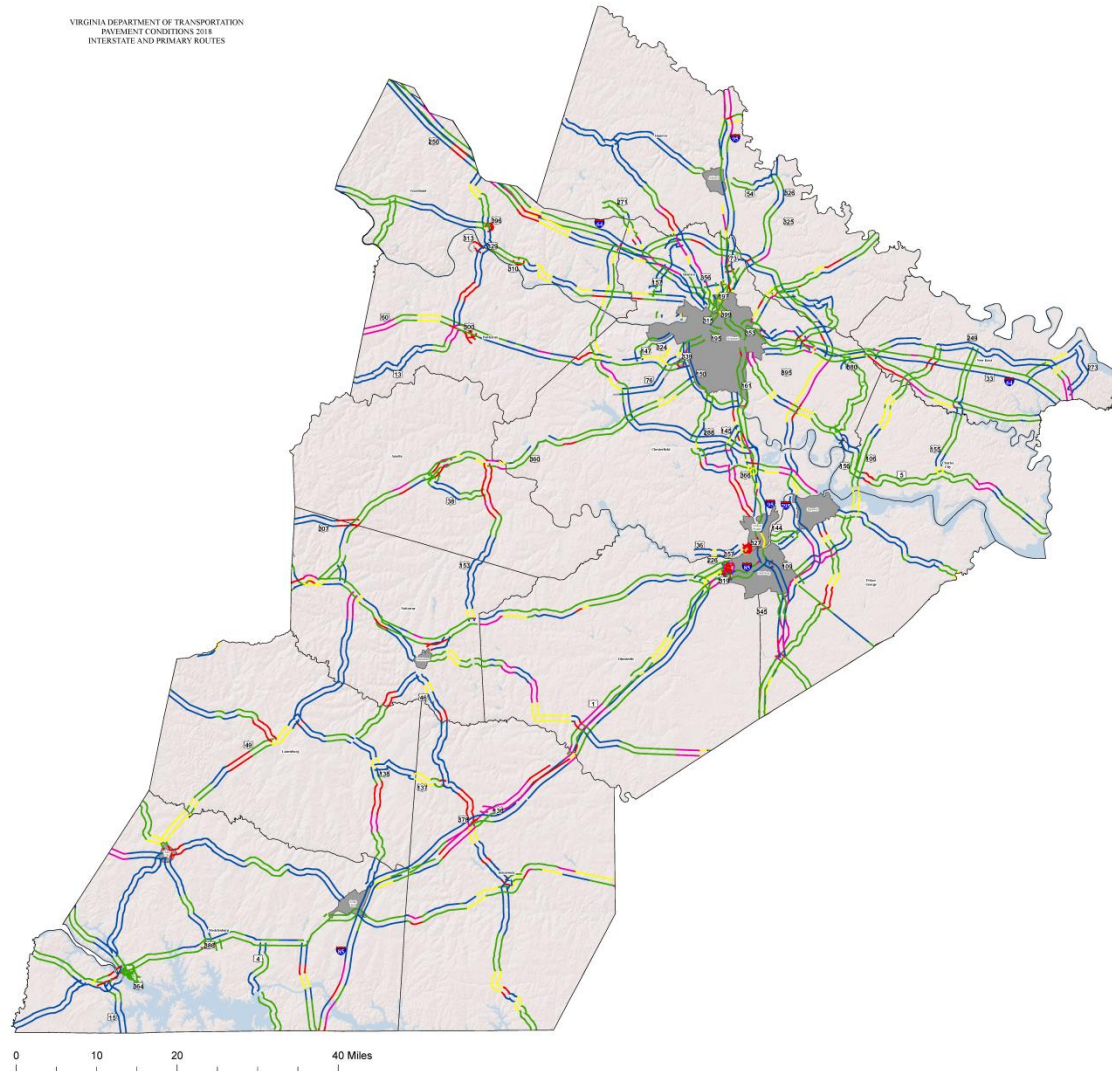


Richmond District

VIRGINIA DEPARTMENT OF TRANSPORTATION
PAVEMENT CONDITIONS 2018
INTERSTATE AND PRIMARY ROUTES



CONDITION DATA	
EXCELLENT	CCI 90 - 100
GOOD	CCI 70 - 89
FAIR	CCI 60 - 69
POOR	CCI 50 - 59
VERY POOR	CCI < 50
NOT RATED	
NOT COLLECTED	
*USUALLY LARGE BRIDGES OR HIGHWAYS MAINTAINED BY LOCALITIES	



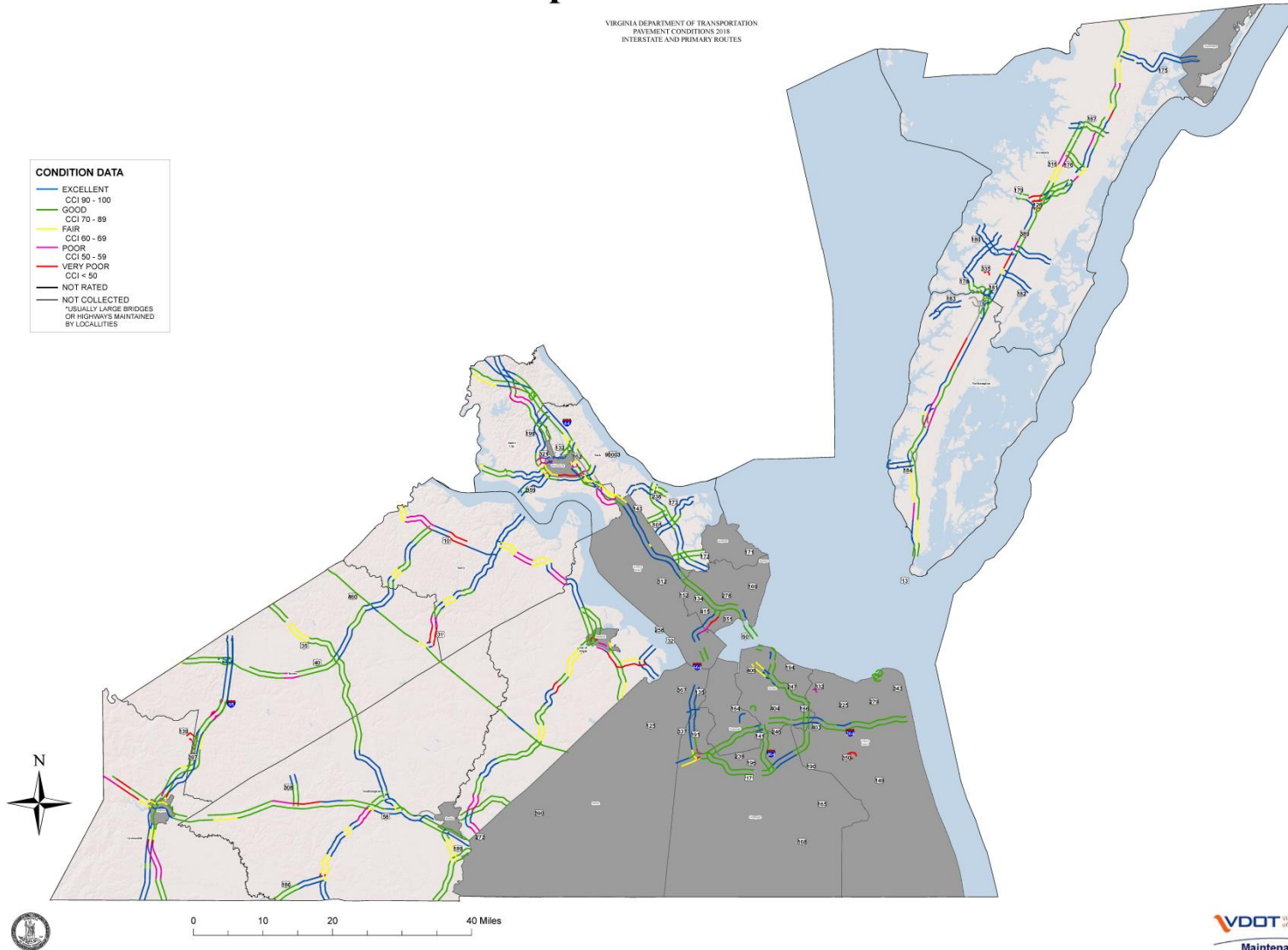


Hampton Roads District

VIRGINIA DEPARTMENT OF TRANSPORTATION
PAVEMENT CONDITIONS 2018
INTERSTATE AND PRIMARY ROUTES



CONDITION DATA	
EXCELLENT	CCI 90 - 100
GOOD	CCI 70 - 89
FAIR	CCI 60 - 69
POOR	CCI 50 - 59
VERY POOR	CCI < 50
NOT RATED	
NOT COLLECTED	
*USUALLY LARGE BRIDGES OR HIGHWAYS MAINTAINED BY LOCALITIES	

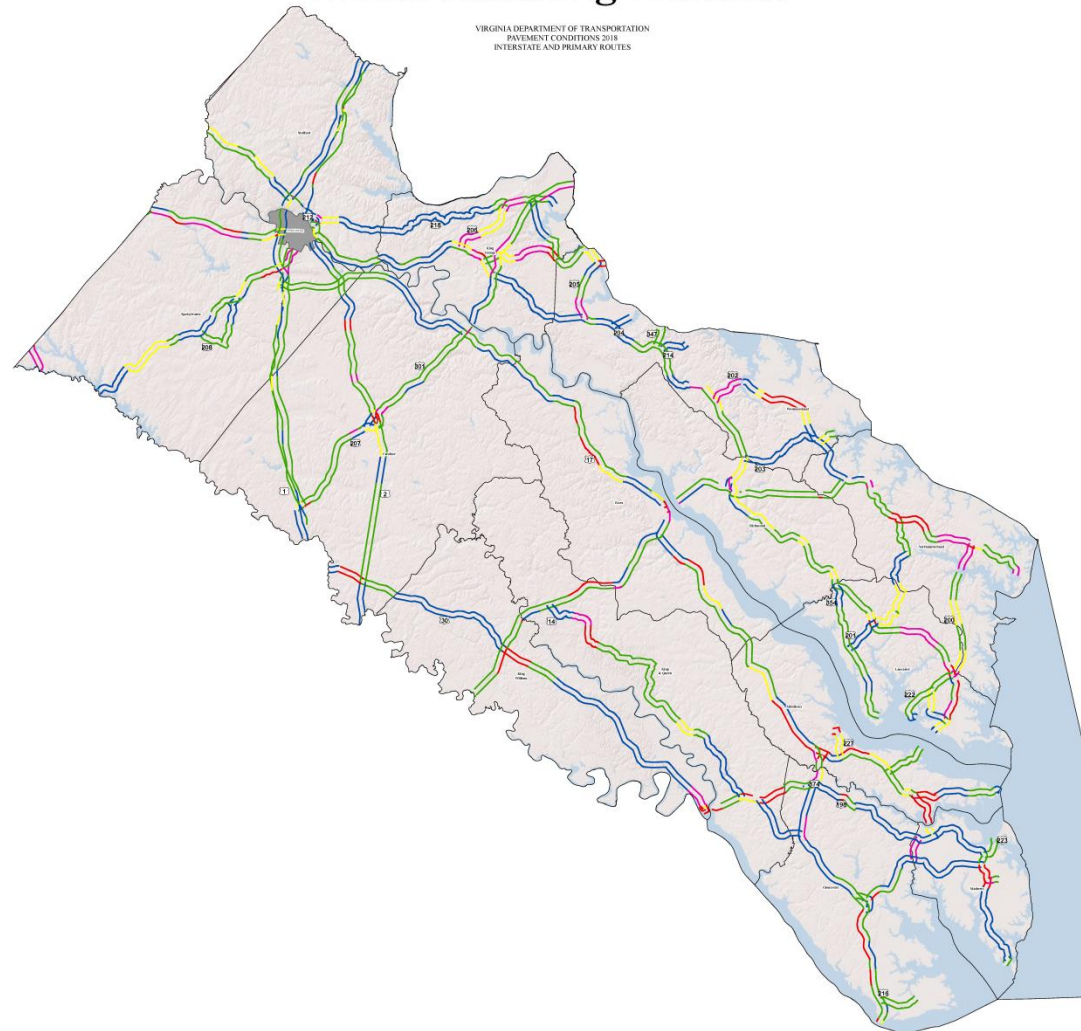




Fredericksburg District

VIRGINIA DEPARTMENT OF TRANSPORTATION
PAVEMENT CONDITIONS 2018
INTERSTATE AND PRIMARY ROUTES

CONDITION DATA	
EXCELLENT	CCI 90 - 100
GOOD	CCI 70 - 89
FAIR	CCI 60 - 69
POOR	CCI 50 - 59
VERY POOR	CCI < 50
NOT RATED	
NOT COLLECTED	
*USUALLY LARGE BRIDGES OR HIGHWAYS MAINTAINED BY LOCALITIES	



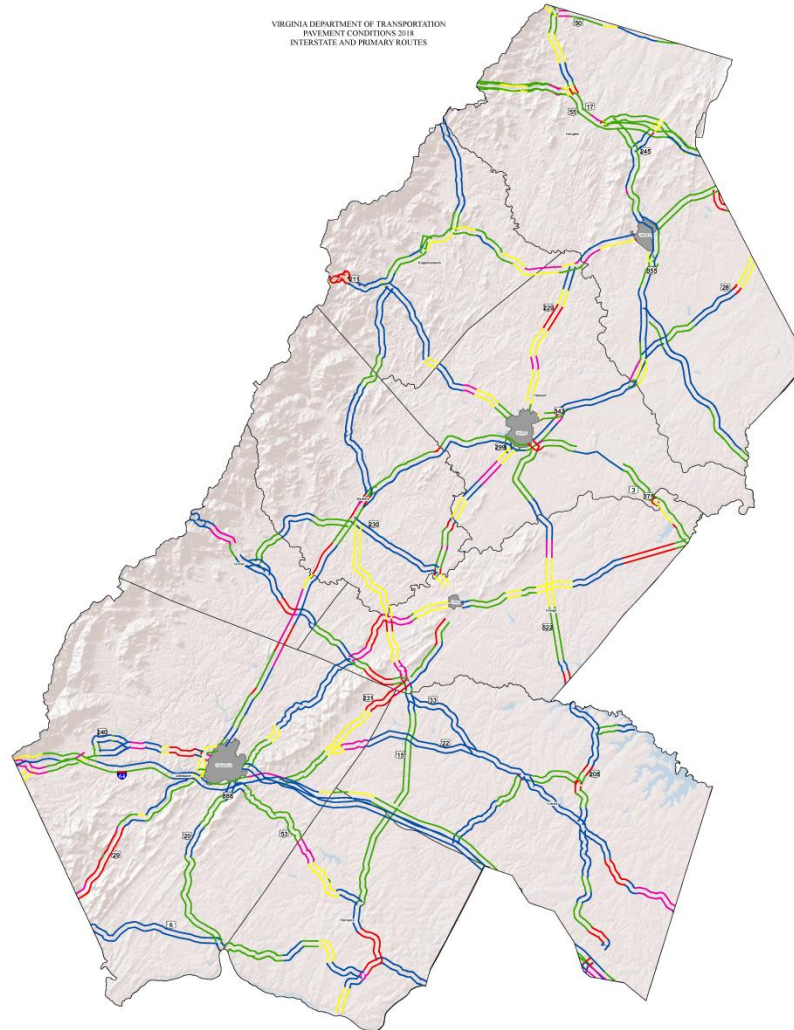
0 10 20 40 Miles



Culpeper District

VIRGINIA DEPARTMENT OF TRANSPORTATION
PAVEMENT CONDITIONS 2018
INTERSTATE AND PRIMARY ROUTES

CONDITION DATA	
EXCELLENT	CCI 90 - 100
GOOD	CCI 70 - 89
FAIR	CCI 60 - 69
POOR	CCI 50 - 59
VERY POOR	CCI < 50
NOT RATED	
NOT COLLECTED	
*USUALLY LARGE BRIDGES OR HIGHWAYS MAINTAINED BY LOCALITIES	



0 10 20 40 Miles

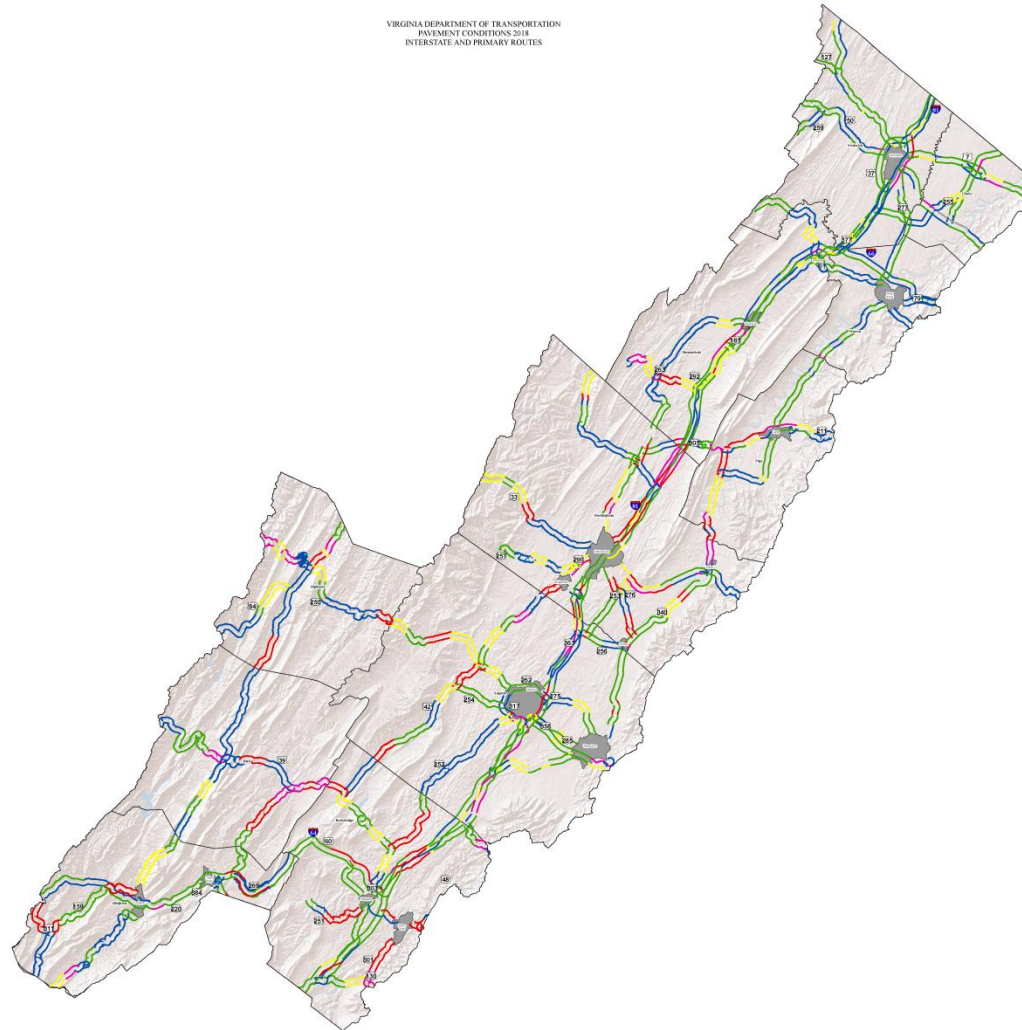


Staunton District

VIRGINIA DEPARTMENT OF TRANSPORTATION
PAVEMENT CONDITIONS 2018
INTERSTATE AND PRIMARY ROUTES



CONDITION DATA	
EXCELLENT	CCI 90 - 100
GOOD	CCI 70 - 89
FAIR	CCI 60 - 69
POOR	CCI 50 - 59
VERY POOR	CCI < 50
NOT RATED	
NOT COLLECTED	
*USUALLY LARGE BRIDGES OR HIGHWAYS MAINTAINED BY LOCALITIES	



0 15 30 60 Miles

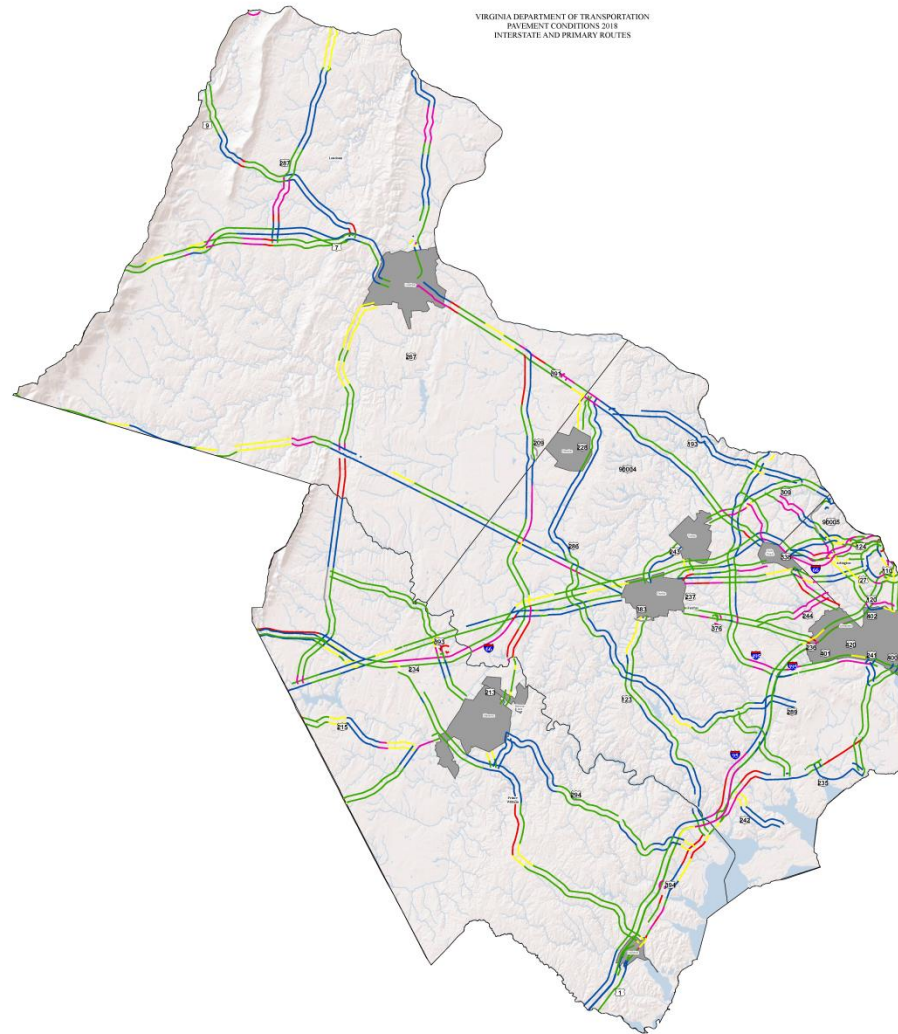


NOVA District

VIRGINIA DEPARTMENT OF TRANSPORTATION
PAVEMENT CONDITIONS 2018
INTERSTATE AND PRIMARY ROUTES



CONDITION DATA	
EXCELLENT	CCI 90 - 100
GOOD	CCI 70 - 89
FAIR	CCI 60 - 69
POOR	CCI 50 - 59
VERY POOR	CCI < 50
NOT RATED	
NOT COLLECTED	
*USUALLY LARGE BRIDGES OR HIGHWAYS MAINTAINED BY LOCALITIES	



APPENDIX E: PAVEMENT RIDE QUALITY BY DISTRICT AND COUNTY – 2018

Table E1. Pavement Ride Quality by District and County for Interstate System – 2018

District	County No.	County Name	Lane Miles (LM) Rated, Interstate	Deficient Ride Quality, LM	% Deficient Ride Quality
Bristol (1)	10	Bland	85.13	0.74	0.86%
	86	Smythe	108.50	0.93	0.86%
	95	Washington	157.19	1.62	1.03%
	98	Wythe	169.98	0.90	0.53%
District 1 Total			520.80	4.19	0.80%
Salem (2)	11	Botetourt	105.40	3.22	3.06%
	17	Carroll	102.52	1.08	1.05%
	60	Montgomery	112.51	1.39	1.23%
	77	Pulaski	68.73	1.38	2.01%
	80	Roanoke	102.55	1.64	1.60%
District 2 Total			491.71	8.71	1.77%
Richmond (4)	12	Brunswick	80.03	1.76	2.20%
	20	Chesterfield	134.67	5.89	4.37%
	26	Dinwiddie	117.39	9.57	8.15%
	37	Goochland	114.24	0.08	0.07%
	42	Hanover	166.82	3.19	1.91%
	43	Henrico	367.97	34.94	9.50%
	58	Mecklenburg	75.52	1.74	2.30%
	63	New Kent	79.60	1.29	1.62%
	74	Prince George	122.86	6.33	5.15%
District 4 Total			1259.10	64.79	5.15%
Hampton Roads (5)	40	Greensville	67.23	0.93	1.39%
	47	James City	34.70	0.35	1.01%
	61	Nansemond	12.95	0.65	5.00%
	64	Norfolk	270.30	25.45	9.42%
	75	Princess Anne	86.40	3.32	3.84%
	91	Sussex	69.24	1.32	1.90%
	99	York	201.24	35.73	17.76%
District 5 Total			742.06	67.75	9.13%
Fredericksburg (6)	16	Caroline	92.98	2.33	2.51%
	88	Spotsylvania	91.89	0.06	0.07%
	89	Stafford	90.52	0.22	0.25%
District 6 Total			275.39	2.61	0.95%
Culpeper (7)	2	Albemarle	120.65	2.78	2.31%
	30	Fauquier	86.31	2.04	2.36%
	54	Louisa	65.77	0.06	0.10%
District 7 Total			272.73	4.88	1.79%
Staunton (8)	3	Alleghany	157.52	2.05	1.31%
	7	Augusta	174.13	0.84	0.48%
	34	Frederick	101.32	0.34	0.33%
	81	Rockbridge	195.46	1.61	0.82%
	82	Rockingham	107.71	1.18	1.10%

District	County No.	County Name	Lane Miles (LM) Rated, Interstate	Deficient Ride Quality, LM	% Deficient Ride Quality
	85	Shenandoah	136.22	0.50	0.36%
	93	Warren	55.53	0.24	0.43%
District 8 Total			927.89	6.76	0.73%
Northern Virginia (9)	0	Arlington	57.29	5.45	9.52%
	29	Fairfax	433.62	26.03	6.00%
	76	Prince William	187.57	3.52	1.87%
District 9 Total			678.48	35.00	5.16%
Statewide			5168.16	194.69	3.77%

Table E2. Pavement Ride Quality by District and County for Primary System – 2018

District	County No.	County Name	Lane Miles (LM) Rated, Primary	Deficient Ride Quality, LM	% Deficient Ride Quality
Bristol (1)	10	Bland	152.06	18.59	12.23%
	13	Buchanan	181.31	45.67	25.18%
	25	Dickenson	161.45	71.91	44.54%
	38	Grayson	236.10	53.45	22.64%
	52	Lee	323.98	35.47	10.95%
	83	Russell	288.41	47.45	16.45%
	84	Scott	273.08	55.75	20.42%
	86	Smythe	168.61	34.51	20.47%
	92	Tazewell	346.63	73.61	21.24%
	95	Washington	236.95	63.94	26.98%
	97	Wise	331.55	74.94	22.60%
	98	Wythe	134.77	12.25	9.09%
District 1 Total			2834.90	587.54	20.73%
Salem (2)	9	Bedford	373.60	46.18	12.36%
	11	Botetourt	250.58	33.73	13.46%
	17	Carroll	197.02	17.76	9.02%
	22	Craig	119.06	29.42	24.71%
	31	Floyd	109.17	5.74	5.26%
	33	Franklin	239.89	25.54	10.65%
	35	Giles	225.41	22.22	9.86%
	44	Henry	340.88	25.62	7.52%
	60	Montgomery	189.99	20.98	11.04%
	70	Patrick	228.06	29.16	12.78%
	77	Pulaski	100.63	7.16	7.11%
	80	Roanoke	200.27	14.91	7.44%
District 2 Total			2574.56	278.42	10.81%
Lynchburg (3)	5	Amherst	281.13	18.94	6.74%
	6	Appomattox	146.04	12.69	8.69%
	14	Buckingham	193.47	4.55	2.35%
	15	Campbell	305.80	20.50	6.70%
	19	Charlotte	259.26	10.81	4.17%
	24	Cumberland	98.37	3.96	4.03%
	41	Halifax	409.90	21.65	5.28%
	62	Nelson	246.83	24.40	9.89%
	71	Pittsylvania	499.22	19.51	3.91%
	73	Prince Edward	179.98	3.56	1.98%
District 3 Total			2620.00	140.57	5.37%
Richmond (4)	4	Amelia	113.85	6.44	5.64%
	12	Brunswick	232.61	34.22	14.71%
	18	Charles City	88.70	4.58	5.17%
	20	Chesterfield	574.96	121.31	21.10%
	26	Dinwiddie	228.80	31.85	13.92%

District	County No.	County Name	Lane Miles (LM) Rated, Primary	Deficient Ride Quality, LM	% Deficient Ride Quality
Richmond (4)	37	Goochland	192.91	22.65	11.74%
	42	Hanover	227.44	33.68	14.81%
	43	Henrico	336.91	119.32	35.42%
	55	Lunenburg	124.11	6.07	4.89%
	58	Mecklenburg	400.18	38.42	9.60%
	63	New Kent	182.94	59.35	32.44%
	67	Nottoway	203.39	7.82	3.84%
	72	Powhatan	126.74	7.78	6.14%
	74	Prince George	185.29	23.01	12.42%
District 4 Total			3218.83	516.50	16.05%
Hampton Roads (5)	1	Accomack	273.17	23.82	8.72%
	40	Greensville	80.70	6.32	7.83%
	46	Isle of Wight	196.27	16.15	8.23%
	47	James City	172.36	14.68	8.52%
	61	Nansemond	2.29	0.13	5.59%
	64	Norfolk	24.22	5.77	23.81%
	65	Northampton	142.12	2.28	1.60%
	87	Southampton	266.93	17.89	6.70%
	90	Surry	96.84	4.38	4.53%
	91	Sussex	219.26	16.74	7.63%
	99	York	147.77	20.14	13.63%
District 5 Total			1621.93	128.30	7.91%
Fredericksburg (6)	16	Caroline	283.70	10.87	3.83%
	28	Essex	171.08	8.42	4.92%
	36	Gloucester	185.21	11.89	6.42%
	48	King George	206.00	11.79	5.72%
	49	King & Queen	135.56	14.53	10.72%
	50	King William	109.03	6.07	5.57%
	51	Lancaster	125.33	20.92	16.69%
	57	Mathews	65.71	9.65	14.68%
	59	Middlesex	131.29	8.55	6.51%
	66	Northumberland	110.53	6.72	6.08%
	79	Richmond	105.94	5.58	5.27%
	88	Spotsylvania	212.68	21.04	9.89%
	89	Stafford	166.24	17.61	10.59%
	96	Westmoreland	139.01	13.42	9.65%
	111	City of Fredericksburg	4.33	1.41	32.49%
District 6 Total			2151.64	168.47	7.83%
Culpeper (7)	2	Albemarle	358.33	27.14	7.57%
	23	Culpeper	209.13	3.99	1.91%
	30	Fauquier	321.69	4.49	1.40%
	32	Fluvanna	101.72	6.03	5.93%
	39	Greene	86.91	3.75	4.32%
	54	Louisa	241.53	12.52	5.18%
	56	Madison	157.74	4.13	2.62%

District	County No.	County Name	Lane Miles (LM) Rated, Primary	Deficient Ride Quality, LM	% Deficient Ride Quality
	68	Orange	188.71	10.21	5.41%
	78	Rappahannock	156.35	0.96	0.61%
District 7 Total			1822.11	73.22	4.02%
Staunton (8)	3	Alleghany	147.33	28.00	19.01%
	7	Augusta	387.45	23.81	6.15%
	8	Bath	148.74	33.84	22.75%
	21	Clarke	135.68	8.57	6.32%
	34	Frederick	313.95	15.41	4.91%
	45	Highland	141.72	12.34	8.70%
	69	Page	134.12	9.21	6.87%
	81	Rockbridge	257.95	39.69	15.39%
	82	Rockingham	390.88	22.50	5.76%
	85	Shenandoah	190.54	18.46	9.69%
	93	Warren	89.34	5.34	5.97%
District 8 Total			2337.70	217.17	9.29%
Northern Virginia (9)	0	Arlington	137.66	110.16	80.02%
	29	Fairfax	761.09	210.82	27.70%
	53	Loudoun	379.68	30.22	7.96%
	76	Prince William	375.05	89.27	23.80%
District 9 Total			1653.48	440.47	26.64%
Statewide			20835.15	2550.66	12.24%

Table E3. Pavement Ride Quality by District and County for Secondary System – 2018

District	County No.	County Name	Lane Miles (LM) Rated, Secondary	Deficient Ride Quality, LM	% Deficient Ride Quality
Bristol (1)	10	Bland	331.65	76.77	23.14%
	13	Buchanan	836.92	227.37	27.17%
	25	Dickenson	775.06	350.65	45.24%
	38	Grayson	695.59	285.16	41.00%
	52	Lee	834.14	317.30	38.04%
	83	Russell	961.32	458.86	47.73%
	84	Scott	815.01	359.13	44.06%
	86	Smythe	768.13	221.55	28.84%
	92	Tazewell	780.07	240.66	30.85%
	95	Washington	1,275.44	440.62	34.55%
	97	Wise	752.42	210.03	27.91%
	98	Wythe	611.24	177.34	29.01%
District 1 Total			9,436.99	3,365.44	35.66%
Salem (2)	9	Bedford	1,527.53	728.19	47.67%
	11	Botetourt	798.80	432.48	54.14%
	17	Carroll	1,155.34	385.36	33.35%
	22	Craig	286.68	164.26	57.30%
	31	Floyd	638.48	272.40	42.66%
	33	Franklin	1,933.56	662.02	34.24%
	35	Giles	450.97	136.23	30.21%
	44	Henry	1,347.43	609.54	45.24%
	60	Montgomery	718.56	193.71	26.96%
	70	Patrick	1,041.16	434.44	41.73%
	77	Pulaski	628.84	224.67	35.73%
	80	Roanoke	1,085.90	517.31	47.64%
District 2 Total			11,613.25	4,760.61	40.99%
Lynchburg (3)	5	Amherst	846.08	469.40	55.48%
	6	Appomattox	784.15	367.50	46.87%
	14	Buckingham	843.91	213.20	25.26%
	15	Campbell	1,330.61	660.13	49.61%
	19	Charlotte	818.32	252.85	30.90%
	24	Cumberland	429.18	156.65	36.50%
	41	Halifax	1,572.40	271.28	17.25%
	62	Nelson	588.49	338.34	57.49%
	71	Pittsylvania	2,457.68	851.87	34.66%
	73	Prince Edward	654.18	244.29	37.34%
District 3 Total			10,325.00	3,825.51	37.05%
Richmond (4)	4	Amelia	653.26	145.10	22.21%
	12	Brunswick	1,011.89	389.82	38.52%
	18	Charles City	263.71	163.45	61.98%
	20	Chesterfield	3,200.88	895.81	27.99%
	26	Dinwiddie	999.48	419.55	41.98%

District	County No.	County Name	Lane Miles (LM) Rated, Secondary	Deficient Ride Quality, LM	% Deficient Ride Quality
Richmond (4)	37	Goochland	652.90	270.63	41.45%
	42	Hanover	1,632.43	614.28	37.63%
	55	Lunenburg	687.90	152.89	22.23%
	58	Mecklenburg	1,156.04	306.33	26.50%
	63	New Kent	409.05	162.69	39.77%
	67	Nottoway	539.42	158.77	29.43%
	72	Powhatan	618.78	121.76	19.68%
	74	Prince George	584.09	185.46	31.75%
District 4 Total			12,409.83	3,986.54	32.12%
Hampton Roads (5)	1	Accomack	1,073.76	662.29	61.68%
	40	Greensville	543.51	197.70	36.37%
	46	Isle of Wight	812.37	145.94	17.96%
	47	James City	612.67	114.80	18.74%
	65	Northampton	470.43	291.53	61.97%
	87	Southampton	1,184.49	433.08	36.56%
	90	Surry	489.12	194.10	39.68%
	91	Sussex	797.95	280.63	35.17%
	99	York	567.44	85.64	15.09%
District 5 Total			6,551.74	2,405.71	36.72%
Fredericksburg (6)	16	Caroline	892.69	205.44	23.01%
	28	Essex	477.27	135.90	28.48%
	36	Gloucester	591.59	180.54	30.52%
	48	King George	332.69	58.69	17.64%
	49	King & Queen	456.85	100.88	22.08%
	50	King William	489.20	92.80	18.97%
	51	Lancaster	411.70	164.76	40.02%
	57	Mathews	262.82	108.79	41.39%
	59	Middlesex	328.17	81.44	24.82%
	66	Northumberland	648.01	341.41	52.69%
	79	Richmond	387.10	173.69	44.87%
	88	Spotsylvania	1,414.18	120.56	8.53%
	89	Stafford	1,227.36	175.49	14.30%
	96	Westmoreland	592.34	268.49	45.33%
District 6 Total			8,511.97	2,208.88	25.95%
Culpeper (7)	2	Albemarle	1,361.87	496.53	36.46%
	23	Culpeper	726.14	198.98	27.40%
	30	Fauquier	1,275.87	325.28	25.49%
	32	Fluvanna	568.22	61.36	10.80%
	39	Greene	294.22	79.80	27.12%
	54	Louisa	1,023.45	211.10	20.63%
	56	Madison	427.86	89.37	20.89%
	68	Orange	575.73	132.68	23.05%
	78	Rappahannock	266.37	75.26	28.25%
District 7 Total			6,519.73	1,670.36	25.62%
	3	Alleghany	427.54	256.47	59.99%

District	County No.	County Name	Lane Miles (LM) Rated, Secondary	Deficient Ride Quality, LM	% Deficient Ride Quality
Staunton (8)	7	Augusta	1,550.15	536.26	34.59%
	8	Bath	515.18	319.93	62.10%
	21	Clarke	334.94	92.52	27.62%
	34	Frederick	1,015.67	184.97	18.21%
	45	Highland	227.40	98.20	43.18%
	69	Page	497.10	58.84	11.84%
	81	Rockbridge	886.19	501.46	56.59%
	82	Rockingham	1,293.88	155.46	12.02%
	85	Shenandoah	850.84	277.59	32.63%
	93	Warren	320.04	43.41	13.56%
District 8 Total			7,918.93	2,525.11	31.89%
Northern Virginia (9)	29	Fairfax	5,085.10	1,609.81	31.66%
	53	Loudoun	2,031.35	308.14	15.17%
	76	Prince William	2,156.08	445.49	20.66%
District 9 Total			9,272.53	2,363.44	25.49%
Statewide			82,559.97	27,111.60	32.84%